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SCIENCE AND HUMAN PROSPECTS[1]

By Professor ELIOT BLACKWELDER

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IN this fateful year, one should need no excuse for departing from the common practice wherein the president of the society devotes his final address to the field of his own research. It seems to me that the occasion calls for a subject of larger importance and one that has a more direct relation to the welfare of the nation. Therefore my remarks on this occasion will bear upon some aspects of education in science and its relation to the future welfare of humanity.

It seems to me that a teacher of geology, or indeed of any other science, should devote himself not only to giving his students information, and explaining processes and theories—however important those educational duties may be—but especially to training young people in the scientific way of thinking and helping them to acquire the scientific spirit. To my mind, that is his most important function.

Since geology is considered a science—albeit not one of the so-called exact sciences—and since we call ourselves scientists, it may be well to ask at this point—what, essentially, is science? In general terms the dictionaries say that it is knowledge established, organized and systematic. To me, however, this concept is not adequate. In the words of the great French mathematician, Poincaré: "A collection of facts is no more a science than a heap of stones is a house." Verified knowledge is one element, organization and classification are necessary and so is the testing of hypotheses, but I can not regard any of these as the core of science. To me the basic thing about science is an attitude or habit of

[1] Address of the retiring president of the Geological Society of America, delivered at the annual meeting in Austin, Texas, on December 26, 1940.

mind, a way of thinking which is characteristic of those entitled to be called scientists. If that is so, most subjects of human concern may be dealt with in a scientific way. The essential condition is freedom from bias and prejudice. The major objective of the scientist is truth, no matter how unpleasant it may be or how much discomfiture it may cause among those who hold cherished beliefs which happen, nevertheless, to be errors. Dr. Crapsey once remarked that: "Truth is a brand new virtue." And it may be added that as such it is not yet as widely sought and valued as it should be. It has been well said that "the purpose of science is understanding." This is only a modern version of the well-known admonition of King Solomon to "get understanding."

The scientific method is relatively new. As recently as four centuries ago it was not in vogue even among the most learned thinkers of the time. To-day it is used only incidentally by most of the people in even the most civilized countries. It is hardly an exaggeration to say that the majority of educated persons —even those with college degrees—do not really understand it. Often it is confused with invention or the mere cataloguing and classifying of knowledge. Some years ago, in a nation-wide poll which was taken for the purpose of finding out who was popularly considered to be the greatest scientist in the United States, the choice fell upon Edison, the inventor. But inventions, however useful and ingenious, are only the outgrowth, the by-products, of science. Although invention was originally a matter of mere cut-and-try experiment it has made more and more use of science, until much of it is now highly scientific in the true sense. Even so, the one should not be confused with the other. Science is not invention. The purposes of scientists and inventors are fundamentally different, even when they use similar methods.

As for the majority of mankind, in the less developed countries, their lives have scarcely been touched by science except in the form of some of its tangible products such as machines, radio, or by the services of the sanitarian; and their understanding of science is hardly greater than was that of their ancestors a thousand years ago.

The critical testing of ideas, though a fundamental practice of the scientist, is a habit difficult for the average human being to adopt. An original idea is a brain-child and tends to be jealously cherished as such. To expose it to the cold light of reason takes a sort of Spartan courage that is too often undeveloped and yet is one of the essential attributes of any one who aspires to be called a real scientist. To be merely logical with facts selected for a purpose is much easier than to divest oneself of bias. Steadfast courage and a renunciation of false pride are required in the search for opposing rather than supporting evidence.

How high shall we appraise the value of the fortunate speculator who happens without much evidence to hit upon the right explanation far ahead of others, as compared with the patient investigator who carries a firm structure of fact and controlled theory with him all the way? The former has uses, but it is chiefly to the latter that steady scientific progress is due. Loose speculation is an ingrained habit of humanity, but the careful scientist realizes that many problems are now insoluble because the necessary data are not yet obtainable. He will, therefore, restrain his fancy, devoting his efforts to objectives that are within his reach, content to leave to his better informed successors those other questions which are not yet ripe for consideration.

Failing to understand what the real scientist must be and what the essentials of science are, part of the public to-day is led to accept as science various elaborations of intuition, speculation and fancy, such as were much more widely current a few centuries ago. It is regrettable, but in a free country perhaps unpreventable, that the cloak of science should be donned and worn by faith-healers and other mystics who have no comprehension of the meaning of the term. As a result, however, it is hardly surprising that part of the general public has a rather confused impression about science, when it reads serious accounts of such absurdities as a "science of astrology," "the science of phrenology," and many others.

That the scientific method had its beginning in the ancient Greek and probably even earlier civilizations is clear enough, but it was displayed by only a few of the philosophers of that era and not consistently even by that few. This is all the more strange in view of the fact that mathematics and the very art of reasoning, logic, was highly cultivated by the Greeks. True, men like Anaxagoras at Athens had many sound ideas and employed the scientific method to a notable extent, but at the same time they entertained, as firm beliefs, some notions that would now bring a laugh to any schoolboy.

No true scientist would have seriously put forth as a conclusion so fantastic and wholly unverified a notion as the great Aristotle's dictum that earthquakes are due to the surging of the wind through caverns in the earth. Even allowing for the inaccuracies of translation from the Greek, one can find only the slenderest evidence to support this opinion. It was a result of pure speculation upon a subject about which the author probably had not even the most elementary knowledge. Yet it was quoted with approval for twenty centuries. This is all the more inexcusable because a considerable body of definite

information about earthquakes was available in the Greek world of Aristotle's day and there were many pertinent observations on geology that could easily have been made in that epoch, even without modern instruments, if serious attention had been devoted to the problems.

It must be admitted that dogma has been the fashion of the past. For millions of the earth's inhabitants it still remains so. To-day we see the current of progress being reversed in the despot-ridden countries of Europe, where the privilege of freely drawing conclusions from evidence is being restricted and the blind acceptance of official dogma is exalted as a duty if not a necessity.

Even in the last century or two the history of science was marred by many a bitter controversy, between rival leaders and their followers, over theories. A theory was defended like a home citadel, and doubters were deemed enemies actuated by the blackest of motives. Among such bickerings there was by contrast the magnanimity of Charles Darwin who said, regarding the storm of criticism that raged after the publication of "The Origin of Species," "If my book can not stand the bombardment, why then let it go down and be forgotten."

Fortunately, rancorous disputes have nowadays largely ceased to afflict the relations of real scientists. Yet there is still far too much of that spirit in the world at large. It has been well said that "Most men think with their emotions rather than their intellects." The ancient method of verbal combat is still employed in our law courts and legislative halls. Each participant adheres to his thesis. Search is then made for evidence to support it and at the same time to refute its opponents. An equal effort is made to suppress or depreciate any facts that may prove to be embarrassingly adverse.

The debating society may be a good place to train lawyers, but the partisan attitude of "win the argument and confound the opponent" is an unhealthy state of mind for a young scientist. Indeed, he can never become a true scientist until he outgrows that mental habit. Rather he should cling to the advice of the wise old Quaker, William Penn: "In every debate, let *truth* be thy aim, not victory." Perhaps it is our sporting instinct, derived, it may be, from our age-long struggle against each other, that makes us usually more interested in winning a contest than in finding the truth.

Although the gathering of facts can not in itself develop a science, yet facts we must have, in infinite number and variety, even though they are only the bricks to be used by the builder. The mere multiplication of facts, the piling up of observations closely similar to hundreds of others is properly regarded as of less value than the search for explanations, principles and laws. While the layman thinks of Major Powell as the intrepid explorer of the Colorado River and its Grand Canyon, discovering, even at the risk of death, the wild beauty of its scenery and the details of its geologic section, it is fitting that geologists should honor him even more for his clear exposition of the principles of the base-level of stream erosion and the antecedent river.

In view of the fact, already mentioned, that we can seldom foresee what utility any scientific fact or principle will eventually have, we can not afford to neglect any aspect of science. Discoveries in one field often release obstructions that have held back progress in other branches of science, and thus permit further advances. On the other hand, by regimenting scientific work and even opinion, along with all other phases of life, for their own immediate purposes, modern tyrants are violating this principle. This they can do with some measure of success for a short time, but eventually their countries will almost surely suffer a degeneration of science, and therefore of the civilization which is based upon it.

Along with the increasing complexity of modern life there has grown up an urgent need for the scientific expert. The demand is being met by many persons who are real scientists but unfortunately by others who do not deserve the name. On that score Dean Roscoe Pound lately said in sarcastic vein that "the administrator is not appointed to office because he is an expert but he is an expert because he has been appointed." We all know of cases that fit this satire, but in all seriousness we may trust that they are not numerous.

Since the public must depend on its experts, it is essential that it should be well justified in placing confidence in them, to the end that such respect will endure. That puts a heavy responsibility upon the individual expert. As Grover Cleveland once said that " a public office is a public trust," no less so should any degree of leadership in science be regarded as a public trust; and so the expert scientist is under great obligation to deserve the confidence of the public. His intellectual honesty will need to be outstanding and unwavering. To-day, in this country, the scientist has already won such esteem to a large degree, although he is compromised and discredited now and then by the shortcomings of the less conscientious and careful of his colleagues.

Many years ago, a former president of our society, R. A. Daly, speaking informally as a visitor to one of my classes, advised the boys to "think to scale." It would be hard indeed to pack more meaning into three words. The person who *thinks to scale* sees the relative value of each fact he uses and of each objective before him. He can then economize his time by confining his attention chiefly to the important and

significant problems. On that point the wisest of the Roman emperors, Marcus Aurelius, is said to have remarked that: "Every man is worth just so much as the things are worth to which he devotes his earnest efforts." It might be somewhat disquieting to many of us if we should measure ourselves by that principle.

More than three centuries ago Sir Francis Bacon urged the application of the scientific method, as he then conceived it, to human affairs and problems in general, but we are still far short of having adopted his advice, although all our experience since his day confirms its value. The greatest progress has been made thus far in the physical sciences and scarcely less in the biological. The scientific method and attitude of mind also pervade to a very large degree the related professions of engineering and medicine.

In such fields of study as economics and sociology, the complex and fluid nature of the basic data that must be used and the influence of human prejudice, which closely touches these subjects, has greatly impeded their emergence from speculative philosophy and their rise toward the scientific level. In addition they need a more general adoption of the scientific attitude and method. Can we not apply these to human affairs, subdue the emotional considerations, and brush away the cherished errors of the past? Then we should be able to move more rapidly toward a real understanding of principles, for we are justified in believing that such principles do exist.

In ethics, which is in some respects the most important of all subjects of human inquiry, we have made no great progress beyond the Greeks of Aristotle's day. Even now the study of human conduct is but slowly emerging from its age-long status as an appendage of religion. Would it not bring fruitful results to study ethics in the same scientific spirit that already pervades such a field of research as physiology? Without a firmly based and widely accepted science of ethics, the other natural sciences alone may allow us to stumble eventually to ruin for want of adequate guidance. Under the direction of the engineer, dynamite is an effective aid in construction and promotes industrial progress; but in the hands of the criminal it means murder and destruction. The difference is only one of ethics.

But for the deficiency of science in politics, statecraft and ethics perhaps we should not find ourselves now threatened by the plague of military despotism, which is more deadly in its modern form than any pestilence. We have used the scientific method in engineering and medicine for a century and have found it good—far more effective than the old ways of speculation or of trial-and-error. In spite of the difficulties involved why not then extend it to other fields?

To have science flourish, there must be complete freedom of inquiry and discussion. The beneficial influence of such freedom is indicated by the extraordinary development of philosophy and the sciences among the Greeks in the fourth to sixth centuries B.C., in the Germany of the nineteenth century and in modern America. Scholars properly insist on this necessity and guard their hard-earned right to intellectual liberty; nor is this freedom of research so firmly held but that it takes a little defending, all the while, from the bigots who would close to discussion certain trends of thought of which they chance to disapprove.

But if the scientist is to deserve and therefore keep his freedom, even in a republic, he should be equally scrupulous about his own responsibility to the public. He has no right to claim on the one hand immunity from restraint, and on the other hand license to be unreliable. It is the less responsible members of our profession who most endanger our freedom of thought, for it is their words that tend to discredit the very science to which they are nominally attached and thus bring all science into disrepute.

Jefferson, Franklin and other founders of our American Union fully realized that a well-informed people was essential to the success of the republic. Although a lover of freedom, Goethe understood the difficulty of making a democracy succeed, remarking that "the trouble with democracy is that it has to wait for an enlightened public opinion." More pessimistic commentators, like Disraeli, were confident that the experiment could end only in disaster because they believed that even the best popular education that was practically attainable would be inadequate.

To be good, a system of education must be suited to its time in history. The boys of ancient Persia were taught "to ride and to shoot and to speak the truth." In their day, nearly 3,000 years ago, that was education enough, but now it would be of little avail, although the last item (speak the truth) has eternal value.

If we were willing to accept the "Nazi" plan of society we should need only a small highly educated upper caste. The rest of the people would be given only training and indoctrination. But if we want freedom and the so-called democratic way of life, then we need the most widespread and effective education that our mental equipment will permit. In our own system, a few wise leaders would be helpless in the face of a grossly ignorant populace, swayed chiefly by its emotions and prejudices. Too often this has been true in democracies thus far, and in America it is still a dangerous factor. So I conclude that we must have, as soon as we can provide it, far better and more extensive education, and a general adoption of the scientific attitude of mind. Is that a large order? It surely is—perhaps too much to ex-

pect—but it may well be the price of our liberty and the survival of our own type of civilization.

Hitler is quoted as having said that no people is capable of governing itself or even of planning its own affairs. If the majority of the people are to be kept in ignorance, he is doubtless right. As our life becomes more complex our problems become more difficult. To solve them badly may mean disaster. To solve them well requires adequate knowledge and especially clear thinking. Bias and prejudice are liabilities or handicaps that we can not well afford and hence should try by all means to reduce. If, in a republic, we are to have our affairs well handled, we must rear millions of capable unbiased persons to make those varied problems their life concerns. That, it seems to me, demands the scientific attitude of mind and an efficient system of education expressly devised for that purpose; for it is not something which we gain by inheritance or in the common experiences of life.

To insure a well-informed and intelligent people is a most difficult task. History affords no good example of such a nation. It is by no means certain that it is even possible. The eugenicists will probably assert that their advice must be followed, and no doubt there is some hope in their principles and plans; but beyond that it seems evident that education is our best chance. It means educating more people and educating most of them longer—perhaps continuously throughout life. Most important of all it means educating them far more wisely and efficiently. As a scientist I am perhaps biased in believing that the most important element in this education is the scientific attitude of mind. That does not mean that every person must become a scientist, but that he must acquire the habit of thinking as a scientist. It means that the great majority should understand what science is, what it stands for and its value to society. They should then be able to recognize the true scientist and distinguish him from the impostor. It will also enhance their capacity to judge the merits of their leaders and the general issues of the day.

Having harped at length on the importance of science, I must ask you not to misunderstand me as implying that science is all we need. It is no panacea for our troubles. Indeed, if we were exclusively scientific, we should not be human at all. There are other things that are also necessary—love, art, imagination, intuition, loyalty, industry, and many others. It is my purpose merely to emphasize the opinion that science is one of the most indispensable factors in civilization. We must become more scientific and especially more widely scientific.

To say that one vital function of society is more important than another is as pointless as to say that the lungs are more important than the heart. We may, however, be sure that effective education is one of the indispensable concerns of a free civilized nation. In the opinion of Dr. Copeland "education is incomparably the most important function of Society." Without it the state could not endure for even a century, for in no other way can the long slowly won progress of the past be effectively transmitted. Good education is one of the greatest means of national advancement. Poor education insures the decline of a people and even their disappearance as a nation.

Conditions in our schools and even in our colleges and universities to-day are far less satisfactory than they should be in view of our acute need of the best education we can provide. Curtis[2] is inclined to ascribe this partly to the fact that many teachers, as well as students, have had little or no training in science and partly to the type of teaching that is all too prevalent, especially in our lower schools. Too much of it is dogmatic, and the student is not trained to think for himself. There is far too much emphasis upon the learning of facts, on the mistaken supposition that knowledge, as distinguished from understanding, is the chief object of schooling.

Since in order to progress we must constantly improve our education, we shall have to have more teachers, especially better and wiser teachers, and teachers who are not only competent to train youth but who are allowed to utilize their competence in teaching under a minimum of administrative control. In my opinion no mature teacher who needs to be told by a principal or a dean how to teach deserves to be employed as a teacher. There has grown up in recent years a widespread tendency to overstress the importance of teaching methods and to give school executives wide powers of direction over the daily work of the individual teacher. Such practice overlooks the fact that good teaching is a matter of individuality, that the teacher, to be successful, must be a true scholar, and that scholars can not be regimented. Also our system has always been less effective than it should be because we have left so much of the education of our rising generation to relatively inexperienced young persons. This seems almost as shortsighted, and in the long run as likely to prove disastrous to the nation, as to leave our military defense largely to young recruits. The only apparent advantage to this is that it is less expensive than the alternative; but the cheapest system may prove in time to be the least economical.

At this point it may be asked what results we can fairly expect from such improvements in our educational arrangements in the next decade or century. The experienced scientist will understand that sound improvement in human affairs will come only by evo-

[2] SCIENCE, August 4, 1939, pp. 100–101.

lution and after cautious experiments on a small scale rather than by sudden revolutionary changes on a large scale.

One of our greatest dangers lies in the impatience of many people to gain great results quickly. This is natural enough, in view of the brevity of our individual lives. But it is inconsistent with the principles which govern all life. We are a part of nature and, however much we may seem to influence natural processes, it can hardly be denied that we are in fact and on the longer view controlled by nature. Whether we like it or not, slow evolution is nature's way. And so we can scarcely hope to elaborate some theoretical new scheme of social or economic organization, put it into practice on a national or worldwide scale in a few years and have any reasonable prospect of success. Hidden faults and weaknesses are likely to cause failure, and that in turn may exhaust for decades even the healthy impulse toward improvement. The fascination that these schemes have for our youth doubtless has a complex cause, but it may well be due in part to the faulty character of our current education, which has not given them the advantages of the scientific viewpoint. Again, as Daly said, they should learn to "think to scale."

However difficult it may be to forecast future trends more than a few years ahead, the geologist can hardly be expected to overlook the longer view; and so I may now raise a few questions about what may be in store for humanity in another epoch—not a matter of centuries but probably of tens or even hundreds of thousands of years.

There are many who expect that man will make continuous progress toward higher and better things, becoming in the course of time so much wiser, more sensible and reasonable that the world's life will be vastly more happy than it has ever been in the past. War, sickness and poverty would then be abolished. Cruelty, hate and injustice would become obsolete, and we should be living in a sort of Golden Age the like of which we have never even approached. That is a beautiful vision to contemplate, especially in these dark times.

The lessons of historical paleontology may throw a beam of light ahead on this speculation—for of course it is no more than that. As we look back over the history of man we find evidence of great progress since the time of the primitive cave-man, who made crude stone implements but lived in isolated families competing with the wild beasts of the day for such food as could be found or seized. He was indeed only one of the beasts, and it is hard to point out more than a few respects in which he was superior to them. Did the early Stone Age men gradually develop, by slow practice and learning, into modern man? We do not know, but there is little reason to suppose so. All that we know to-day of human paleontology indicates that what we loosely refer to as man comprised a group of at least five and probably eight or more distinct animal species which are generally grouped by zoologists in several genera. These may have originated in various parts of the world, each lived many tens of thousands of years, but eventually with one exception all become extinct. At certain times two or more such species may have coexisted, although probably in different regions. Perhaps they eventually killed off each other, just as the white race in historic times has exterminated the Tasmanians and certain other primitive tribes. But to-day only one species survives, and he has apparently had the field all to himself since the middle of the last glacial epoch, or about 30–50,000 years ago, according to current estimates. Each of these species appears to have been as distinct from the others as species and genera of animals usually are.

There is nothing to indicate that the very primitive *Sinanthropus* made much progress in culture during his long career in China. He learned to use fire—probably to make it—and to fashion a few simple tools of stone and bone; but that seems to have marked the limit of his inventive capacity. For shelter and safety from attack he seems to have crept into caves, like many another beast.

Neanderthal man, generally placed in the genus *Homo*, shows evidence of a distinctly higher culture. He made more varied and better tools of chipped flint, of wood, bone and other materials ready to his hand. But with a brain which appears to have been inferior, even his long career as a species seems not to have sufficed for him to invent pottery, polished or ground stone tools, to learn to domesticate and use other animals rather than to hunt them, or to grow crops—not to mention building houses or using metals. Apparently he had some ideas about spirits and a future life, for he buried his dead with some care and placed in their graves some of their ornaments and weapons; but we have no evidence that he developed any art of drawing or sculpture, and none of his tools were finely wrought. There is evidence of only slight progress during the long age through which he lived, and at his best his cultural level was distinctly lower than that of the most primitive savages now known to anthropologists.

How these various species of men came into existence is unknown and may well remain so. But there is nothing to suggest that their origin differed in any way from that of the other animals. To suppose that it did would be gratuitous speculation. Indeed, had it not been for the achievements of the latest of these species, the *Hominidae* would never have been entitled to special notice as anything more than somewhat peculiar mammals.

From biological friends whom I have consulted, I learn that they are not yet agreed upon the question of how a new species originates. In fact, there is some difference of opinion as to just what constitutes a species, as contrasted with a race, a variety or even a genus. While waiting for the biologists to work out these problems, we may use the term *species* a bit vaguely in its current meaning, and we may tentatively adopt the now preponderant view that new species originate not by gradual imperceptible changes, but by sudden mutations, either extensive enough to produce a distinct species at once or occurring in series which eventually culminate in full specific status.

However any new species actually originated, its parental species doubtless continued to exist for a time without much change. The new kind expanded in numbers and, if more effective, eventually overran and exterminated the older one. It then went on living without important physical change until it was in turn crowded out by more efficient animals or succumbed to other adverse factors in its environment.

Have we any reason to suppose that *Homo sapiens* is not subject to the same process or that his fate will not be similar? He differed from earlier species of men very slightly in physical form and structure. His achievements and the shapes of his crania suggest that he possessed, from the outset, not only a larger but probably also a distinctly better brain, which has enabled him to learn more extensively, to devise complicated languages, and eventually to develop what we now call civilization. This progress seems to have gone forward on a steadily rising curve. For perhaps 20,000 years *Homo sapiens* was only a savage, a wandering hunter. In the next 5,000 years or more he advanced locally to the status of a shepherd and even a village farmer. In another 3,000 years he learned to extract and use metals, form cities or states and even nations, and become skilful in many of the finer arts. Accelerated advance in the next 1,000 years led to books, commerce, literature and philosophy. The last century or two has witnessed a rapidity of material progress, in communication and far-flung organization that exceeds anything previously known; and with it has come much growth in ideas and in the complexity of economic and social arrangements.

Are we justified in assuming from the contemplation of that curve that it will continue to rise indefinitely, and at a similar rate? Is there in all geologic or human history any precedent for that? Other animal species of the past have followed career curves that involved a rise, culmination and decline. We have seen the same law controlling the nations and even races of humanity. Will our own species also reach its climax and then deteriorate? And if that happens, how and when will it occur? As yet we have but little basis for answers to such questions.

In contrast with his progress in ways and ideas, *Homo sapiens* seems to have undergone only slight physical changes, even in the estimated 30,000 years of which some records have come down to us. Anatomically there seems to be no evidence whatever of any progress—no increase in cranial capacity, probably no appreciable change in brain anatomy. In the last 3,000 years, for which some evidence is available, there is no sign of any improvement in native intelligence. Man's actions are still governed more largely by his emotions and subconscious mental elements than by his intellect. His savage instincts, that we like to think began to be conquered thousands of years ago, are still present beneath the surface and reappear at unexpected intervals even in civilized man. Among the more backward modern races of humanity they have scarcely changed.

In short our surviving species of *Homo,* being one of the mammals, is probably as definitely limited in his possibilities as are the other species of that class. Just as we do not expect a dog to learn algebra, although he can learn to open a door, so we probably ought not to expect more from present-day man than his brain is capable of attaining. As Hawkins,[3] the English paleontologist, sees it: "Our mental capacity is a specific character." If this is the truth of the matter, it may be overoptimistic to expect our own species to rise far above his present stage of mentality. Notable improvement along lines already established, and a raising of the other two thirds of the Earth's population to or above the level of the present civilized minority, may well take place over the centuries and thousands of years yet remaining in the expectable future life of this species. His contribution to biological progress will then have been made, and if history is to repeat itself, he will then be ready for conquest, if not extermination, by some other type of being—perhaps some new species of the *Hominidae* that has more innate capacity for progress.

Just as it would have been difficult for even a most intelligent trilobite to imagine the fish, which was destined to drive him from the scene, so it is not easy for us to forecast the nature and potentialities of that new species of *Homo* which may appear in the distant future—unless indeed our genus itself has by that time run its course and is not destined to offer the world anything further. It is of little consequence whether such a new species may have smaller teeth, a skin less hairy or taller stature. The only way in which he is likely to outstrip *Homo sapiens* effectively is in the quality of his brain. Will he be able to

[3] Herbert Leader Hawkins, "A Paleontologist Looks at Life," *Proc.* Cotteswold Nat. F. C., Vol. 23, 1930, p. 219.

absorb knowledge more rapidly and remember it better? Will his imagination be keener, will he reason out his problems more effectively; and, above all, will his life and conduct be controlled by his intellect rather than by his feelings? If so, he may be able to take knowledge in larger doses, profit more by the stored-up experience of others, instead of merely his own, and by the lessons of history. He should be far more educable than any earlier species in the family.

It may be objected that these speculations are hardly optimistic, that they do not present a hopeful picture, and that they do not necessarily envisage continued progress toward a far higher and better human world. To this I must reply that a scientist is under no obligation to be an optimist. His only concern must be to approach nearer to the truth. If the truth offers hope, we may all rejoice. If it fails to do so, we are not thereby justified in denying or even ignoring it. As King Solomon long ago advised, let us get understanding, and by so doing we may reach a serenity of outlook that will fit us better to play a worthy, even though minor, part in the great drama of human evolution.

OBITUARY

CHARLES WALLIS EDMUNDS

CHARLES WALLIS EDMUNDS was born on February 22, 1873, in Bridport, Dorset, England, the son of Thomas Hallett and Caroline (Wallis) Edmunds. In 1883 Thomas Edmunds moved his family to America and established their new home in Richmond, Indiana. There Charles Edmunds received his preliminary education, including a year at the University of Indiana, and from there he went to Ann Arbor in 1896. In Ann Arbor he completed his undergraduate training, found his life work, and established his own home. He was graduated from the University of Michigan, Department of Medicine and Surgery, which later became the University of Michigan Medical School, in 1901. In the following year, as an interne, his keen observation in a cardiac case attracted the attention of Professor Cushny, and thus his association with pharmacology was begun. Keen observation indeed became the keynote of his laboratory teaching. He believed that students too easily lost the purpose and meaning of an experiment in concentration upon the proper handling of mechanical devices.

In 1902 Dr. Edmunds became assistant to Professor Cushny in the Department of Materia Medica and Therapeutics of the University of Michigan and in 1905 assumed the direction of the department when Cushny returned to England, an early recognition of his leadership. In 1907 he was named professor of materia medica and therapeutics and later the phrase, director of the Pharmacological Laboratories, was added. The former title was retained to carry out the connection between the old materia medica and the new science of pharmacology, at that time still in the pioneer stage.

In 1905 Dr. Edmunds worked with Gottlieb and Magnus at the University of Heidelberg, in 1907 with Cushny at University College, London, and in the summers of 1908 and 1909 he worked at the Hygienic Laboratory, now the National Institute of Health, in Washington. The connection with the last institution was of the greatest importance, as it led to the close cooperation of the laboratory at Ann Arbor with various national organizations.

Dr. Edmunds held many responsible posts in and out of the university whereby he demonstrated his keen interest in medical education and in the development of pharmacology, and he brought to these tasks an unsurpassed art of gracious dignity and diplomacy. He was secretary of the Medical School from 1911 to 1921, assistant dean from 1918 to 1921, a member of the executive committee of the Medical Faculty from 1936 to 1939, and in 1937 he was appointed to the executive committee of the Graduate School. He was a member of the U. S. Pharmacopeial Convention from 1910 onward, served as chairman of its most important committees, and was elected to its presidency in 1940. He served on the Council of Chemistry and Pharmacy of the American Medical Association from 1921 and was chairman of the committee of the Council on Grants to support research on problems connected with therapeutics. He was prominently identified with the executive committee of the National Research Council in 1939 and was a member of its drug addiction committee from 1930. As a signal distinction he was appointed to the International Committee on Drug Standardization, Health Committee of the League of Nations, and in 1925 participated in its deliberations in Geneva.

Standards might be termed the theme of Dr. Edmunds's life and work. Recognition of his abilities in this respect came to him early. For example, he was a member of the committee for revision of the U. S. Pharmacopeia in 1910–1920, 1920–1930 and 1930–1940. In the first instance he was chairman of the committee to make recommendations regarding bioassay methods, and the studies of this committee led to the introduction of such methods into U.S.P. IX, the first pharmacopeia in the world to make bioassay methods obligatory.

Standardization of digitalis was an early and con-

tinuing interest. More recently anti-anemic preparations gained a considerable portion of his attention, so that he was made chairman of the Pharmacopeial Advisory Board having control over potency claims for all official liver and stomach preparations used for the treatment of primary anemia. Dr. Edmunds's prominence in connection with pharmaceutical standards was based upon not only his interest but his own research work, the underlying object of which was improvement in therapeutics. Outstanding were his observations upon the effect of intravenous injections of dextrose in the treatment of diphtheria complicated by circulatory collapse, observations which have saved the lives of many individuals. Dr. Edmunds probably considered this his most important contribution to pharmacological research, for he made it the subject of his lecture delivered upon the occasion of his selection in 1937 as Henry Russel lecturer at the University of Michigan, the highest faculty honor award.

Dr. Edmunds not only was a keen observer but had a sharp perception of the underlying meaning of important situations and conferences. He was a friendly, sympathetic counselor and, although chary of direct advice, adept at finding the means to a solution or decision without it; in other words, eager and able to help one to help oneself. He loved and respected tradition and in pharmacological teaching helped to create it. He came into the field when laboratory teaching had only just been made a part of medical education and was vigorous in cultivating its growth. He was co-author with Cushny of "A Laboratory Guide in Experimental Pharmacology," the permanent form of their instructions to the students. Through the years this guide has been modified, but its principles still direct the laboratory work in pharmacology at Michigan. Also the text-book of pharmacology which Cushny took seven years to write was repeatedly and ably revised by Dr. Edmunds at great expense in time and effort.

There has been in the past much opposition to the existence of pharmacology as a separate entity in the medical school, resulting too often in its treatment as a step-sister of physiology or biochemistry. Against such treatment Dr. Edmunds took a strong stand. Closely related were his views upon the standards of pharmacology and pharmacologists and his insistence on freedom from commercialism.

Dr. Edmunds's authority and ability as a director and his relations with such bodies as the National Research Council brought to the University of Michigan at least two large research projects, the work of which was vastly aided by his scientific interest and informed advice. One of these was the pharmacological part of the coordinated investigation of the relation of chemical structure and physiological action among morphine derivatives and related substances as a means of attack upon the drug addiction problem. The other project was an extensive investigation of caffeine, coffee and decaffeinated coffee.

Dr. Edmunds possessed artistic abilities which he found time to employ in two directions. He was a great lover of flowers, and in the springtime his hyacinths and tulips were worth going far to see. For more than twenty years his summer holidays were spent at Monhegan, Maine, and most of the time there was devoted to painting in water color. In spite of the fact that his hand was idle in this field for the remainder of the year, each summer saw the execution of very fine work which was exhibited with distinction in many places.

In the death of Dr. Edmunds the University of Michigan Medical School lost a fine teacher and counselor, his associates an inspiring leader, and the science of pharmacology one of its ablest pioneers.

NATHAN B. EDDY

RECENT DEATHS

DR. ANNIE JUMP CANNON, astronomer of the Harvard Observatory, died on April 13 at the age of seventy-seven years.

WILLIAM REMSEN APPLEBY, professor of metallurgy and dean emeritus of the School of Mines of the University of Minnesota, died on April 8 at the age of seventy-six years.

DR. REUBEN EDSON NYSWANDER, professor of physics and electrical engineering and dean of the School of Science and Engineering of the University of Denver, died on April 8 at the age of sixty-three years.

DR. FRANK CLINCH HAMMOND, professor of gynecology and honorary dean of the School of Medicine of Temple University, died on April 12. He was sixty-six years old.

DR. HUGO KAHL, curator of entomology at the Carnegie Museum, Pittsburgh, until last January when he became curator emeritus, died on February 19 in his eighty-second year.

HENRY OSBORN TAYLOR, distinguished for his work on the history of civilization, died on April 13 at the age of eighty-four years.

SCIENTIFIC EVENTS

GRANTS AND FELLOWSHIPS OF THE AMERICAN COLLEGE OF DENTISTS

THE American College of Dentists offers each year a small number of grants-in-aid and research fellowships. These are intended primarily for individuals preparing themselves for a career as teachers and

investigators in one of the dental preclinical sciences, or those desiring to approach the problems of clinical dentistry through a discipline in the sciences fundamental to such problems. They are designed to be of help particularly to young teachers and research workers having a dental degree, working in well-established institutions and needing small financial subsidies to carry on their projects.

All applications for funds to be granted on July 1 must be on regular forms and in the hands of the chairman of the Research Fellowship Board by December first. All applications are passed upon by the board at a conference held in Chicago each February.

At the last meeting of this committee, the sum of $3,300 was recommended to be distributed as follows:

$600 grant-in-aid to Harrison R. Hunt and Carl A. Hoppert, East Lansing, Mich., for a continuation of an investigation on inheritance factors in dental caries of rats.

$500 grant-in-aid to M. L. Tainter, Dental School, College of Physicians and Surgeons, San Francisco, for a continuation of an investigation of the general problems involved in the evaluation of the abrasiveness of dentifrices and their individual constituents.

$1,200 research fellowship, to June R. Schamp, Dental School, College of Physicians and Surgeons, San Francisco, for an investigation, by means of a critical study by a new method, of the potency of analgesic and other drugs used singly and in combination.

$500 grant-in-aid to William H. Bauer, St. Louis University Dental School, for an investigation of the influence of various sex hormones on tooth and bone development and formation in dogs and monkeys as caused by the administration of certain estrogens, particularly estradiol benzoate.

$500 grant-in-aid to W. D. Armstrong, School of Dentistry, University of Minnesota, for an investigation of the effect on teeth and bones of a fluorine free diet.

The rules governing the granting and use of research funds of the American College of Dentists, as well as special blanks for applying for such funds, can be secured by writing to the Chairman of the A.C.D. Research Fellowship Board, Dr. A. L. Midgley, 1108 Union Trust Building, Providence, R. I.

EXPEDITIONS OF THE SMITHSONIAN INSTITUTION

ACCORDING to the annual report of explorations of the Smithsonian Institution, twenty expeditions were sent out during the year 1940.

Around the headwaters of Green River, Wyo., Dr. Charles E. Resser sought fossil remains of trilobites which abounded in the shallow waters off low beaches approximately half a billion years ago.

Dr. C. Lewis Gazin collected bones of extinct reptiles and mammals in the Manti National Forest, Utah, and in southwestern Wyoming. These included a nearly complete specimen of the six-horned, sabre-tusked uintathere.

In the Glass Mountains of west Texas Dr. G. Arthur Cooper collected fossils representing the life of the Permian period in geological history, about 300,000,000 years ago. The Smithsonian-Firestone Expedition, led by Dr. William M. Mann, director of the National Zoological Park, worked in Liberia, where collections of living mammals and reptiles were made. About 3,000 specimens of fish, reptiles and insects were added to the collections of the U. S. National Museum.

Dr. Alexander Wetmore, assistant secretary, made extensive bird collections in the Guanacaste Province of Costa Rica. W. L. Brown, chief taxidermist of the National Museum, gathered material for exhibition habitat groups of Rocky Mountain sheep and goats in the mountains of Alberta and British Columbia. An extensive addition to the collections was made by Dr. and Mrs. Hobart M. Smith, who worked in Mexico collecting reptiles and amphibians.

The life habits of the Alaska king crab, important in the canning industry, were studied in Alaskan waters by Dr. Waldo L. Schmitt, who was associated with an expedition of the Bureau of Fisheries.

Captain Robert A. Bartlett made extensive collections in Greenland waters. He also gathered for the Smithsonian collection birds, flowers and mosses from the Ironbound and Duck Islands, and visited a group known as the Thom Islands, which are completely covered with nests of eider ducks and Arctic terns.

Mollusks from the west coast of Mexico and the Gulf of California were collected by Mr. and Mrs. Russell Hawkins, Jr. Dr. Agnes Chase studied the grasses of Venezuela at the request of the Venezuelan Ministry of Agriculture.

Excavations of the Indian village of Patawomeke in Virginia, scene of the kidnapping of Pocahontas, was continued by Dr. T. D. Stewart, anthropologist; David I. Bushnell, Jr., found in the same state what may prove to be a habitation site of the earliest known inhabitants of North America, who hunted extinct bison in the West in the closing days of the last ice age. Dr. Frank H. H. Roberts, Jr., continued his excavations in Colorado of a known camp site of these people. Among his finding was a bone needle, which shows that they had at least reached the cultural stage of sewing garments. The cultural pattern of the Carrier Indians of British Columbia was studied by Dr. Julian H. Steward, of the Bureau of American Ethnology.

Comparison of the languages of the Navajo, the largest Indian tribe in the southwestern United States, and the Indians around Juneau, Alaska, nearly 2,500 miles away, were made by Dr. John P. Harrington.

He found unquestionable evidence of the close relation of the two groups.

THE JELLIFFE LIBRARY

THE acquisition of the Jelliffe Library by the Neuro-Psychiatric Institute of the Hartford Retreat makes certain the continuing availability of these wisely collected psychiatric and neurological works to research workers.

The value of the collection, numbering as it does more than 10,000 volumes and 25,000 reprints, some of them dating back to the fifteenth century, lies principally in the discriminating sense of Dr. Jelliffe, who has devoted a life-time to collating the best in psychiatric literature from Pinel and Esquirol down to the present.

The reprints themselves are notable for the painstaking care with which they have been bound according to subject matter. For instance, if one were interested in epidemic encephalitis, he would find all reprints having to do with this subject bound together. In two or three hours one would get more information on epidemic encephalitis than with a week's work with card catalogues or reference to the journals from which the reprints were derived.

They are very catholic: there are 15 shelve-feet on epilepsy. Reprints on hysteria, compulsion neuroses, aphasia, brain tumors, spinal cord, poliomyelitis, multiple sclerosis are also assembled in the same complete manner.

There are also included in the library complete sets of practically every significant neurological or psychiatric publication from every country in the world.

Recently, after personal examination, Morris C. Leikind, of the Library of Congress, stated that "The psychoanalytic section of the library is one of the best collections of its type to be found anywhere. The value of this collection as an instrument of research lies in its totality. It not only represents a lifetime of singleminded collecting, but a lifetime of research and contributions to knowledge. The breakup of the collection would therefore destroy the very thing which Dr. Jelliffe tried to create—that is, its unity."

It is a source of gratification to the institute that funds have been made available with which to acquire this great collection intact, and to insure its maintenance. The library is now being shipped to Hartford, where it will take its place on the shelves of the Science Library of the institute, side by side with the many psychiatric volumes which have been acquired since the institute's founding in 1822.

Dr. Jelliffe has expressed satisfaction that the library is to be assured of a permanent home under conditions which will be of satisfying benefit to future generations of psychiatrists and neurologists.

C. CHARLES BURLINGAME

CONFERENCE OF STUDENTS OF CONNECTICUT VALLEY COLLEGES

FOR the eleventh consecutive year students of science in ten Connecticut Valley colleges met on April 12 at Mount Holyoke College. The conference, which is modeled on the organization of the American Association for the Advancement of Science, originated with, and is conducted entirely by the students. Each year it is a guest of one of the ten participating colleges, and this year it returned to Mount Holyoke, where it was first planned and held.

Dr. Robley D. Evans, professor of physics at the Massachusetts Institute of Technology, was the guest speaker. He made an address on "Atom Smashing and its Modern Applications." In the morning individual and group papers, demonstrations and exhibits were presented by students of all the science departments. These included a wide range of subjects such as "Post-Glacial Plant Deposits of the Connecticut Valley," "D. C. Amplification of Ionization Currents and the Chemical Significance of this Method," "The New Hengar Kjeldahl Apparatus," "Paragenesis of Galena Vein in Leverett, Mass.," "Plantation Rubber in the Amazon Basin," "(Tit-Tat-Toe)" "Diet Possible on a Sub-Average Income," "Study of the Delusions of a Group of Psychotic Negroes," "Insulation from Cold by Feathers, by Hair, and by Mineral Wool and other Materials," "The Making of Bird Skins."

A new feature of the program was the reading of a number of papers describing the various types of summer work in science in which undergraduates could take part. In physics, "Work at the Mellon Institute of Industrial Research" and "Volunteer Work in Spectroscopy at the Massachusetts Institute of Technology" were described. Other fields included "Summer Work in Archeology in Chaco Canyon, N. Mex." and "The Wyoming University Geology Summer Camp."

Demonstrations of astronomical instruments were held at the observatory, and the Attic Laboratory of Physics was open for inspection.

SYMPOSIUM ON QUANTITATIVE BIOLOGY AT COLD SPRING HARBOR

THE symposium for 1941 will deal with "Genes and Chromosomes—Structure and Organization." It will occupy two weeks, from June 18 to July 2. The following subjects, among others, will be considered by authorities in each field: structure of chromosomes as revealed by optical methods; salivary gland chromosomes, structure and analysis by ultraviolet rays by biochemical and chemical methods; spontaneous and induced mutability; birefringence, viscosity and the electron microscope as tools for the study of submicroscopical structures; x-ray diffraction; physical

analysis of mutation phenomena; properties of giant molecules, proteins, nucleic acid and viruses; atomic interchanges in organic molecules.

Among 36 participants on the program 11 are cytologists, 7 geneticists, 3 biophysicists, 10 biochemists, 4 physicists and 1 mathematician. Most of the participants will be in residence at the Biological Laboratory during the two weeks' period. All those interested may attend and take part in the discussion of papers without further invitation. Programs will be sent on request.

The research facilities of the Biological Laboratory are at the disposal of investigators throughout the summer. Several of the participants in the symposium, as well as a number of other scientific men, will make the laboratory their summer headquarters.

THE SOCIETY OF VERTEBRATE PALEONTOLOGY

At the organization meeting in Cambridge, Mass., on December 28, 1940, a new society to be known as The Society of Vertebrate Paleontology was formed. Its stated objects are "to promote the science of vertebrate paleontology, especially in North America, and to serve the common interests and facilitate the cooperation of all persons concerned with the history, evolution, comparative anatomy and taxonomy of vertebrate animals, as well as the field occurrence, collection and study of fossil vertebrates and the stratigraphy of the beds in which they occur." Any one over twenty-one years of age and actively interested in these purposes is eligible for membership. In addition to vertebrate paleontologists, strictly speaking, it is hoped that the society will serve as a common meeting ground and coordinating body for those concerned with fossil vertebrates from both of the two approaches, geological (stratigraphy, paleogeography, etc.) and biological (phylogeny, comparative anatomy, evolutionary principles, etc.). The dues are one dollar per year.

The society will hold an annual winter meeting and also occasional special meetings, including field excursions when practicable. Such a special meeting and excursion is tentatively scheduled to be held in Nebraska in the summer of 1941 and the next annual meeting will be held during the Christmas holidays in Boston. The society will also gather and distribute to its members information and news of interest to them, names and addresses, notes on activities in this field, compilations of laws concerning collecting, brief special bibliographies and the like. It does not plan to undertake technical publication.

The constitution will become fully effective at the close of the next annual meeting. Until that time Dr. A. S. Romer, of Harvard University, is serving as provisional president and the undersigned as provisional secretary-treasurer. Inquiries should be addressed to the secretary-treasurer, Dr. George Gaylord Simpson, The American Museum of Natural History, New York, N. Y.

THE VIRGINIA ACADEMY OF SCIENCE

THE results of recent scientific research work in Virginia will be reported on May 2 and 3 when the Virginia Academy of Science, with its nine hundred and fifteen members, holds its nineteenth annual meeting at the Medical College of Virginia at Richmond. At the banquet in the Hotel John Marshall on May 2, following an address of welcome by Dr. William T. Sanger, president of the Medical College, and a response by Dean Wortley F. Rudd, president of the academy, the annual research prize and the Jefferson Medal, both awarded for outstanding work in research, will be presented by Dr. Frank A. Geldard, professor of psychology at the University of Virginia and chairman of the research committee. Austin H. Clark, curator of the division of echinoderms, U. S. National Museum, and president of the Washington Academy of Sciences, will be the banquet speaker. The subject of his address will be along the line of a policy he has followed for many years—"Find Young Virginia Scientific Talent and Subsidize It." It will be most appropriate for the occasion since at this particular meeting of the academy the members of the sixty-five secondary school science clubs now in the state are completing their organization of a Junior Academy of Science under the leadership of Hubert J. Davis, Matthew Whaley High School, Williamsburg. Besides, the encouragement of young people interested in science has been taken as one of the main projects of the academy. Headquarters for the juniors will be the Thomas Jefferson High School with Miss Martha H. Lipscomb as local chairman. Primarily for their benefit, the House of Magic, demonstrated during the New York World's Fair, will be presented in the Virginia Room of the Hotel John Marshall immediately following Mr. Clark's address.

On May 1, a number of conferences will be held for the purpose of hearing committee reports having to do with various academy projects. During the daytime on May 2 and the morning of May 3, 197 papers will be read in the eleven subdivisions of the academy—13 in astronomy, mathematics and physics, 21 in biology, 12 in botany, 14 in zoology, 31 in chemistry, six in education, 20 in engineering, 20 in forestry, 19 in geology, 22 in the medical sciences and 19 in psychology.

During the meeting, various exhibits will be displayed. Saturday afternoon, May 3, and Sunday, May 4, will be devoted to field trips, one of these being an all-day trip to the Dismal Swamp, under the guidance of experts on the flora and fauna of that region.

STATE ACADEMIES OF SCIENCE

THE annual meeting of the Ohio Academy of Science will be held at Cleveland on May 8, 9 and 10.

THE fortieth annual meeting of the North Carolina Academy of Science will be held on April 25 and 26 at Chapel Hill, under the presidency of Dr. Jasper L. Stuckey, professor of geology at the State College at Raleigh.

THE West Virginia Academy of Science will hold its eighteenth annual meeting on April 25 and 26 at Alderson-Broaddus College, Philippi, W. Va. The exhibit feature will be enlarged this year. There will be about thirty-five scientific and commercial exhibits. Dr. J. E. Judson, professor of biology at the West Virginia Wesleyan College, Buckhannon, is secretary.

THE spring meeting of the Indiana Academy of Science will be held on Friday and Saturday, May 9 and 10, at Cannelton, Indiana, under the presidency of Dr. Paul Weatherwax, professor of botany at Indiana University. Cannelton is located in a region of considerable historic and geologic interest, and there will be conducted field trips in botany, geology and archeology. There will be a trip to Angel Mounds, where archeological excavation is now in progress.

THE Nevada Academy of Natural Sciences was formally organized at the University of Nevada on February 19, by representative professional and amateur zoologists, botanists and geologists of the state.

SCIENTIFIC NOTES AND NEWS

DR. W. B. CANNON, George Higginson professor of physiology at the Harvard Medical School, will be the first recipient of the Friedenwald Medal of the American Gastroenterological Association, which meets in Atlantic City on May 5. The award is made "in recognition of his pioneer utilization of the x-rays in gastroenterology, and his important contributions to the mechanics of digestion, to the elucidation of the sensations of hunger and thirst, and to the development of the science and practice of gastroenterology."

THE Priestley Medal of the American Chemical Society was presented at the St. Louis meeting to Dr. Thomas Midgley, of Worthington, Ohio, vice-president of the Ethyl Gasoline Corporation and chairman of the board of directors of the corporation. The award was made in recognition of his discovery of tetra-ethyl lead as an anti-knock agent for gasoline and for his work on refrigerants used in air-conditioning.

DR. JOHN R. DUNNING, associate professor of physics at Columbia University, has been awarded the Ernest Kempton Adams Research Fellowship. He will continue his study with the cyclotron of the properties of atomic nuclei and the interaction of neutrons.

THE University of Bristol conferred on April 12 the degree of doctor of laws *in absentia* on Dr. James Bryant Conant, president of Harvard University and head of the American National Research Committee, which has been visiting England.

THE University of Aberdeen will confer the doctorate of laws on Professor Arthur Wellesley Falconer, M.D., principal and vice-chancellor of the University of Capetown, South Africa.

AT the Chicago meeting of the American Association of Physical Anthropologists, Dr. William K. Gregory, curator of ichthyology at the American Museum of Natural History and professor of paleontology at Columbia University, was elected president, and Dr. Harry L. Shapiro, associate curator of physical anthropology at the museum, was elected vice-president.

DR. HENRY V. HOWE, professor of geology and petroleum engineering and director of the School of Geology of the Louisiana State University, has been elected president of the Society of Economic Paleontologists and Mineralogists.

OFFICERS of the University of Cincinnati Section of Sigma Xi for the years 1941–43 are: *President,* Dr. Louis Brand, professor of mathematics; *Vice-president,* Dr. Harold Kersten, associate professor of biophysics, and *Secrteary-Treasurer,* Dr. S. B. Arenson, professor of inorganic chemistry.

DR. J. P. BAUMBERGER, professor of physiology at Stanford University, has been granted leave of absence. From April 1 to December 31 he will serve as visiting professor in cytology at Washington University and research associate in the Barnard Free Skin and Cancer Hospital, St. Louis.

LAFAYETTE COLLEGE has received a grant of $2,700 from the John and Mary Markle Foundation to support a study of the viscosity of the blood, which is being carried out under the direction of Professor Eugene C. Bingham, research professor of chemistry, and by Dr. R. R. Roepke, research assistant.

DR. MAX FARRAND, now seventy-two years old, since 1927 director of the Henry E. Huntington Library and Art Gallery at San Marino, Calif., has resigned, his resignation to take effect on July 1. He plans to devote his entire time to research work and writing.

HENRY L. WARD, since 1902 director of the Neville Public Museum at Green Bay, Wis., has presented his resignation to take effect in May. Mr. Ward was director of the Public Museum of Milwaukee from 1902

to 1920; from 1920 to 1933 he was director of the Kent Scientific Museum. Earlier, from 1891 to 1902, he had been successively division manager and vice-president of Ward's Natural Science Establishment at Rochester, N. Y.

DR. ARNULFO ARIAS has been elected president of the Republic of Panama. He had previously held the posts of director of the department of hygiene and of minister to Italy, France and England.

DR. JOHN T. TATE, professor of physics and dean of the College of Science, Literature and Art of the University of Minnesota, and Dr. Louis B. Slichter, professor of geophysics at the Massachusetts Institute of Technology, members of the National Defense Council, were passengers on the Clipper of the Pan American Airways that left for Lisbon on April 7. It is understood that they will join the group of American scientific men now studying defense methods in England.

COMMANDER DONALD B. MACMILLAN will leave on June 20 for his nineteenth expedition to Greenland. The expedition is sponsored by the New England Museum of Natural History, for which he will make a collection of Arctic birds. The party will sail from Boothbay Harbor, Me., and it is expected that it will return on September 1.

DR. HUGH H. SMITH, Dr. Arnold P. Meiklejohn and Dr. William D. Robinson have been appointed members of the Rockefeller Foundation Health Commission, which carries on war work in the field of public health, and will sail for Europe on April 19. Dr. Smith and Dr. Meiklejohn will be attached to the British Ministry of Health, the former serving in the general public health field and the latter in nutrition investigations. Dr. Robinson will proceed to Madrid to take part in the commission's studies of nutrition in Spain.

THE Monday evening lecture of the National Academy of Sciences, which is meeting in Washington on April 28, 29 and 30, will be given by Dr. R. A. Millikan, Dr. H. Victor Neher and Dr. William H. Pickering, the California Institute of Technology. The subject of the lecture is "Testing in India a Theory of the Origin of the Cosmic Rays."

THE Franklin Medal Lecture of the American Philosophical Society, Philadelphia, will be given on the evening of Thursday, April 24, by Dr. Hugh S. Taylor, David B. Jones professor of chemistry at Princeton University. His lecture is entitled "Large Molecules through Atomic Spectacles."

DR. TRACY J. PUTNAM, professor of neurology at the College of Physicians and Surgeons, Columbia University, spoke on "The Surgical Treatment of Athetosis and Paralysis Agitans" at the initiation banquet on April 7 of the Cornell University Medical College Chapter of the Alpha Omega Alpha Society.

DR. C. H. GOULDEN, senior agricultural scientist, of the Dominion Rust Research Laboratory, Winnipeg, gave the tenth series of Frank Azor Spragg Memorial Lectures, from February 25 to 28, at the Michigan State College. The memorial lecture was entitled: "The Fundamentals of Experimentation." The four daily lectures had as their general theme, "The Design and Analysis of Experiments."

DR. ADOLPH KNOPF, Sterling professor of geology at Yale University, delivered the tenth annual James Arthur Lecture on "Time and Its Mysteries" on April 16. The title of the lecture was "The Geologic Records of Time." Since 1906 Dr. Knopf has been a member of the staff of the U. S. Geological Survey, since 1912 as geologist. The Arthur lectureship was established in 1931 by a bequest of the late James Arthur, Brooklyn manufacturer, who had previously presented to the university a collection of more than 1,800 clocks and watches demonstrating the evolution of timekeeping. Other lecturers have been Drs. Robert A. Millikan, John C. Merriam, Harlow Shapley, James Henry Breasted, Daniel Webster Hering, W. F. G. Swann, John Dewey, Arthur H. Compton and Henry Norris Russell.

A JOINT meeting of the four honor societies, Sigma Xi, Tau Beta Pi, Alpha Omega Alpha and Phi Beta Kappa, was held in Detroit on April 2. Addresses were made on "Mental Attitudes for National Defense" by Fred M. Zeder, of the Chrysler Corporation; William J. Cameron, of the Ford Motor Company, and Dr. Charles F. Kettering, of the General Motors Corporation.

A SYMPOSIUM on "Nutrition in Defense of Democracy" was held on April 15 by the Chicago Branch of the American Association of Scientific Workers presided over by Professor Anton J. Carlson, at which the following papers were presented: "Nutrition in the United States To-day," by Dr. Hazel K. Stiebeling, Bureau of Home Economics, U. S. Department of Agriculture; "Nutrition in the Armed Forces," by Dr. Paul E. Howe, colonel of the Sanitary Corps, U. S. Army, and "Nutrition in the United States—a Plan for the Future" by Dr. Russell M. Wilder, of the Mayo Clinic, chairman of the Committee on Nutrition and Foods of the National Research Council.

THE Baskerville Chemical Society, the undergraduate society of students of chemistry at the College of the City of New York, will hold "Open House" on May 9 and 10. On Friday evening the chemistry building will be open to the public and demonstrations

depicting the work of the students will be shown. On Saturday morning at 11:00 A.M., there will be a student seminar, dealing with various phases of chemistry, at which papers will be presented by students representing the various metropolitan and city colleges. There will be an award for the best paper. On Saturday afternoon a parchment scroll, appropriately inscribed, will be presented to Professor Enrico Fermi, of Columbia University, by the Baskerville Chemical Society. After the presentation, Professor Fermi will speak on a phase of his work.

THE second American Congress on Obstetrics and Gynecology will be held in St. Louis from April 6 to 10, 1942. Dr. Fred L. Adair, professor of obstetrics and gynecology and chairman of the department at the University of Chicago, is president of the congress. Dr. E. D. Plass, professor of obstetrics and gynecology and head of the department at the State University of Iowa, is chairman of the program committee. The general plan for the program will be much the same as that of the first congress, which was held in Cleveland in 1939, with sectional meetings for the various groups (nurses, public health, administrators, educators and physicians), general sessions for all members attending the congress and round tables. There will be evening sessions open to the general public.

THE forty-third annual meeting of the Medical Library Association will be held at the University of Michigan Medical School, Ann Arbor, on May 29, 30 and 31, under the presidency of Colonel Harold W. Jones, of the Army Medical Library, Washington, D. C. Hotel headquarters will be at the Michigan Union. The program will include papers on the cooperation of libraries, union catalogues, medical history and industrial medicine.

THE twelfth annual meeting of the Eastern Psychological Association will be held on April 18 and 19. It is announced that the annual dinner will be given on Friday evening at seven o'clock, after which Professor Walter S. Hunter, of Brown University, president of the association, will deliver an address on "Professional Training of Psychologists."

THE thirty-sixth annual meeting of the Southern Society for Philosophy and Psychology was held at Washington, D. C., from April 10 to 12 under the presidency of Dr. John Paul Nafe, professor of psychology and head of the department at Washington University, St. Louis. The address of the president entitled "The Quantification of Psychology" was given after the banquet on Friday evening.

THE thirteenth annual science and engineering fair will be held at the American Museum of Natural History from April 27 to May 4. Exhibits will be on display from public and private schools, science clubs and independent groups. Prizes, amounting to $3,000, based on age groups, will be awarded to the students in biological, physical and engineering sciences.

THE organization meeting of a Metropolitan Section of the Mathematical Association of America will be held on April 19 at Queen's College, Flushing, N. Y. There will be technical sessions both in the morning and in the afternoon. Professor F. H. Miller, of Cooper Union, will preside in the morning and Professor T. Freeman Cope, of Queen's College, in the afternoon. Dr. Paul Klapper, president of the college, will make an address of welcome at the opening of the afternoon session.

THE organization meeting of a Southeastern Division of the American Meteorological Society will be held in cooperation with the University of Miami on May 7, 8 and 9. There will be a Symposium on Tropical Cyclones presided over by Gordon E. Dunn, of Chicago, in which the speakers will be Dr. Sverre Petterssen, director of the meteorological division of the Daniel Guggenheim Aeronautics Laboratory of the Massachusetts Institute of Technology; Ivan R. Tannehill, chief of the division of synoptic reports and forecasts of the U. S. Weather Bureau, Washington; Dr. Patrick J. Harney, of Mount Washington Observatory; Willard F. McDonald, of the U. S. Weather Bureau, Washington, and R. J. Minser, chief meteorologist for the Trans-Continental Western Airways at Kansas City. In connection with the assembly there will be an official staff meeting of the U. S. Weather Bureau presided over by Dr. Francis W. Reichelderfer, chief of the bureau, and scientific visits to the radiosonde laboratory and to the forecasting division of the Pan American Airways. Social events are being arranged. Admission to all sessions will be provided by registration at the meeting. The program can be obtained from E. S. Ellison, chairman of the Seminar Board, Box 1058, Lakeland, Florida.

THE Bulkley Gold Medal of the Garden Club of America for artistic, horticultural and educational achievement was awarded to the Brooklyn Botanic Garden at the International Flower Show in the Grand Central Palace. The medal was awarded in recognition of an exhibit of seventy-six varieties of ivy.

JEFFERSON HOSPITAL, Philadelphia, will receive $330,522 from the estate of the late Mrs. Emily Barton Pendleton to be used for the treatment of cancer and tuberculosis and for research into their causes.

DR. ARTHUR D. HASLER, director of the Lake Ge-

neva Institute of Natural Science, announces a gift to the institute of $500 from the Lake Geneva Property Owners Association for the study of lake nuisances and limnological sequences resulting from pollution. A $300 fellowship to study fishery biology in Lake Geneva, Wisconsin, has been established by Frank W. Schwinn. Applications for this fellowship for the summer of 1941 should be sent to Dr. Hasler, Department of Zoology, University of Wisconsin.

THE *Journal* of the American Medical Association reports that Meharry Medical College at Nashville is making a campaign to raise more than two million dollars for an endowment fund. The General Education Board, which has been contributing toward the annual operating budget of the college, has announced that it will not continue this subsidy after this year. The board has offered conditionally, however, to make endowment grants amounting to $3,700,000 if the college can collect $1,700,000 from other sources. Of this amount $1,500,000 must be raised by July 1. The current endowment is about $800,000. A committee representing medical, educational and journalistic activities is sponsoring the campaign. Dr. Abraham Flexner is national chairman of the endowment program.

DISCUSSION

THE AGE OF JURASSIC DINOSAURS

A RECENT number of *Natural History* contains[1] a very interesting account of the discovery and collection of footprints of a gigantic Sauropod dinosaur identified as those of Brontosaurus, from the Glen Rose formation near Glen Rose, Somervell County, Texas. The American Museum, we are told, is installing these footprints under their excellent mounted Brontosaurus in the new Jurassic Hall. Brontosaurus, Diplodocus, etc., come from the Morrison formation of Colorado. The age of the Morrison was decided to be Jurassic by the late O. C. Marsh, largely because of his belief that the English Wealden was Jurassic, which has long since been disproved. In a great many parts of the world there exist continental beds of greater or less chronological magnitude between the latest marine Jurassic and the earliest marine Lower Cretaceous, and these always have given rise to differences of opinion and more or less controversy as to their age.

To those unfamiliar with Texas geology it may be said that the Glen Rose formation near Glen Rose from which the tracks were collected is thinner than it is farther east, and I am assured by Dr. E. H. Sellards that the tracks actually occur at a horizon which is rather late in Glen Rose time.

The age of the Lower Cretaceous of Texas has been the subject of much misconception in the past, largely from the ill-advised attempts of text-book writers, such as Chamberlin and Salisbury, to substitute the provincial term Comanchean as an independent system (period) co-extensive with the Lower Cretaceous of Europe. This is contrary to the conclusion of students of Cretaceous stratigraphy and paleontology, both American and European.

The Glen Rose is the middle formation of the Trinity group and the base of the Trinity in Texas is now considered younger than the Neocomian of Europe.

In 1911 I correlated it[2] with the late Barremian and Aptian of Europe (*vide* Douville, Kilian, Suess, etc.) correlating the overlying Fredericksburg with the European Albian on the basis of the faunas, and the Washita or upper Comanchean with the European Upper Cretaceous (Cenomanian).

All this leads into the question of the age of the Morrison. I have expressed my opinion long ago,[2] and wish merely to raise the question in the present connection, that if a Jurassic dinosaur (vertebrate chronology) makes footprints at a horizon near the middle of the marine Lower Cretaceous (invertebrate chronology) where do we go from here?

EDWARD W. BERRY
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[1] R. T. Bird, *Nat. Hist.*, 47: 2, 74–81, February, 1941.

[2] E. W. Berry, Maryland Geol. Surv. Lower Cretaceous, 1911 (correlation chart).

OSMOTIC PRESSURE FOR THE PLANT PHYSIOLOGIST

SOME time ago[1] these columns carried a suggestion that the basic definition of osmotic pressure emphasize its function as the cause and not the result of osmosis. Unfortunately the writer based his argument on the erroneous premise that diffusion pressure and osmotic pressure are identical. Subsequently a student of both physiology and physical chemistry has called attention[2] to the chemist's concept of fugacity as a sound basis for understanding osmotic pressure. In line with this concept but worded in explicit terms more commonly used by biologists as a whole, the following statement is offered as a brief exposition of osmosis and the way it works in plant tissues with particular reference to osmotic pressure as the cause of osmosis:

When water molecules are free to diffuse in an aqueous solution or in pure water, they have a certain diffusion pressure. When they move through a differentially permeable membrane as the result of a difference in diffusion pressures on the two sides of the membrane, this special

[1] H. C. Eyster, SCIENCE, 92: 171–172, 1940.

[2] S. C. Brooks, SCIENCE, 92: 428–429, 1940.

case of diffusion is called *osmosis*. The difference in diffusion pressures is therefore called *osmotic pressure*, since it is the cause of osmosis in the same way that diffusion pressure is the cause of diffusion.

Furthermore, if there is pure water on one side of the membrane, the osmotic pressure is a function or property of the aqueous solution on the other side. In this sense such a solution has an osmotic pressure wherever it is, the value of which is controlled by temperature, external pressure and the concentration of solutes.

In the case of a living plant cell and its osmotic relations, there is such a variation in the pressure of the cell wall against the cell contents that the osmotic pressure of the cell as a whole may be much less than that of the cell contents which is proportional to the concentration of solutes when the cell sap is freed from the wall pressure. The wall pressure increases the diffusion pressure of the water within the cell and thus reduces the osmotic pressure of the cell contents to that extent. The osmotic pressure of the cell contents and therefore of the cell as a whole will always be equal to the theoretical pressure (based on concentration of solutes) minus the wall pressure. Since this is the net effect of the solutes in the cell contents, the effective osmotic pressure of a cell at any moment can be called its *net osmotic pressure*. The relationship between it (N), the wall pressure (W) and the theoretical osmotic pressure of the cell contents based on solute concentration (C) is expressed by the equation $N = C - W$. Suitable modification of this equation is necessary when the cell is in contact with a tissue or a solution with an effective osmotic pressure of its own, the effect being to lower the net osmotic pressure of the cell to that extent.

Since plant tissues are characterized in general by variations in solute concentration and in turgor or wall pressures, the concept of net osmotic pressure of the cells is very useful and practical. It can often be measured directly and the measurement used in computations of either wall pressure or solute concentration if one of these is also known. To elementary students it gives the picture of balanced physical forces in living cells. Suction tension is its equivalent in value, but it has no logical connection as a scientific term.

As a statement of the same physical condition, the expression "diffusion pressure deficit" has its merits, but in actual use it is an unwieldy, negative term that makes an unnecessary reference back through the osmotic pressure idea to the basic concept of diffusion. Students find it very difficult to manage. Even by those who prefer it for some purposes, it is seldom used to express the osmotic property of a solution, probably because it actually refers to the solvent and not to the solution. Osmotic pressure is an established term for solutions and cell contents, with a natural appeal to both biologists and physical chemists. If it can be used with suitable qualifying words to describe some of the complex osmotic relations of living cells, it should be employed in the interests of uniformity among the sciences. Surely it should not be abandoned by physiologists just because it has been abused by some through lack of understanding.

CHARLES J. LYON
DARTMOUTH COLLEGE

THE DEMAND FOR SCIENCE BOOKS

THE publication of books on science and technology has shown a steady increase in the United States for the last decade according to statistics compiled by the Bureau of the Census.

The year 1939 thus far marks the peak of production for publishers of books on scientific and technological subjects with a total of 3,432,642 volumes. Figures for that year are the latest available, since the Census of Manufactures, covering production in all American industries, is taken only biennially. The next Census, to be conducted in 1942, will cover 1941 production.

The 1939 total represents an increase of more than a million volumes over the 1937 total of books on science and technology, 2,380,351 volumes.

Separate statistics on production of books on science and technology have been compiled by the Census Bureau biennially since 1925. They are: 1935—1,937,084; 1933—1,611,642; 1931—1,818,585; 1929—2,294,660; 1927—2,392,044; 1925—2,094,343.

The Bible, however, is still America's best seller, as is indicated by the number of Biblical volumes published. Figures covering 1939 show the annual output of Bibles, Testaments and parts of the Bible published in separate covers, to be 7,927,848 volumes, compared with 5,579,317 in 1937. Both 1937 and 1939 recorded tremendous increases in total number of Bibles printed. For earlier census years Bibles published were: 1935—591,173; 1933—666,448, and 1931—1,376,680.

The number of complete Bibles published in 1939 was 2,348,069. Testaments published separately numbered 1,268,614. Parts of the Bible (not whole Testaments) numbered 3,361,234 volumes, while an additional 969,931 Biblical volumes were not classified by text.

While the production of Bibles showed an immense increase, the publication of fiction recorded a heavy decline, 13,511,181 volumes in 1939, compared with 25,454,135 volumes in 1937.

The total number of all books published in 1939 was 180,142,492 volumes, compared with 197,359,076 volumes in 1937; 140,651,953 volumes in 1935; 110,789,913 volumes in 1933; 154,461,622 volumes in 1931, and 214,334,423 volumes in 1929.

The largest single grouping reported was that of text-books for school use, not distributed as to subject-matter, which amounted to 63,274,758 volumes in 1939, compared with 72,771,685 volumes in 1937.

Next high in 1939 in total numbers were books for juvenile readers, 34,848,416 volumes, compared with 29,336,530 volumes in 1937.

Statistics on other books, by class and number, for 1939 and 1937, are given in Table 1.

TABLE 1

Kind	1939	1937
Agriculture and related subjects	1,018,809	1,034,607
Biography	2,384,647	2,754,390
Fine arts	590,885	694,163
History	2,306,829	1,238,806
Law	2,356,395	2,448,165
Medicine	1,868,892	3,923,532
Music (musical notations)	5,682,042	6,722,598
Poetry and drama	1,499,477	1,788,541
Religion and philosophy	6,413,606	6,944,102
Sociology and economics	886,751	1,156,885
Travel and geography	1,482,138	1,641,931
Reference	6,716,403	3,841,442
Miscellaneous	16,196,422	23,367,371
Bluebooks, directories, catalogues, etc.	7,724,351	4,280,525

Publication of pamphlets more than doubled in number, with a 1939 total of 540,536,202, compared with 216,847,761 in 1937.

Maps, atlases and globe covers published in 1939 numbered 64,309,275, compared with 103,867,467 in 1937.

A. W. VON STRUVE

BUREAU OF THE CENSUS

PRESERVATION OF THE CONTINUITY OF THE SCIENTIFIC RECORD

UPON us in the more fortunate continents where research in pure science can still go on there surely rests an obligation to do all we can in aid of our colleagues abroad. The exigencies of the immediate situation are sufficiently clear, but it is now none too early to plan for aid in the restoration of pure science abroad after the war.

Specifically, foreign subscriptions to American scientific journals have fallen off. This means that the continuity of files in foreign libraries may be broken, irretrievably unless the situation is planned for now, and much that is being accomplished by American scientists and by Europeans working in America will be unavailable to the scientists abroad who return after the war to their depleted laboratories and impoverished libraries. Are the publishers and editorial boards of American journals setting aside enough extra copies of their current numbers so that the broken files abroad may be made complete after the war?

Each scientist in this country must know of colleagues abroad with common interests. Are we each buying enough extra reprints of current articles to supply at a more propitious time those abroad who work in our fields? By clear thinking and decisive action on these and related questions much might be done to restore the free culture of science which is now so hard pressed in much of the world.

STUART MUDD

PHILADELPHIA, PA.

SCIENTIFIC BOOKS

RECENT BOOKS IN GEOGRAPHY

AT a time when wide-spread military conquest and a series of international crises have once again focused attention on geography, it is significant to note the appearance of five books in that field between August and December, 1940. Four are revisions of earlier texts, but the fifth is a completely new work.

As a popular treatise of the subject by a professional geographer, Roderick Peattie's "Geography in Human Destiny" (323 pages and 26 illustrations. New York: George W. Stewart. 1940. $3.50) should prove of special interest to those who have had only a grade-school or high-school acquaintance with formal geography.

After introductory chapters on the nature and content of his field, Professor Peattie proceeds to trace the environmental thread in human activity from the Paleolithic Age to the present moment, or, as he regretfully suggests, from "stone ax to dive bomber." He develops his philosophy in a direct and simple, if not highly polished style, and enriches the discussion with frequent citations from broad personal experience and the pens of others. The volume is concluded by comments on the geographic basis of national conservation and a brief treatment of the author's concept of "The Geography of Peace." An interesting feature is the list of further readings of a popular nature which appears at the end.

While some geographers may shrink from its rather strongly environmentalistic tone, and others may doubt the appropriateness of the chapter on evolution, the fundamental soundness of "Geography in Human Destiny" is beyond question. Total lack of pictorial illustration is the greatest shortcoming of the book. Although it contains twenty-six well-executed maps, charts and physiographic diagrams by Arthur Robinson, the many opportunities for clinching arguments or making points more effective through the use of well-selected photographs have been ignored by either the author or the publisher.

Principles of Human Geography. By ELLSWORTH HUNTINGTON. Fifth edition. 594+xxiv pp. 70 maps, 26 diagrams, 2 plates and numerous tables

and photographs. New York: John Wiley and Sons; London: Chapman and Hall. 1940. $3.50.

FOUR times revised and now largely rewritten, "Principles of Human Geography" should well serve its purpose as a comprehensive elementary text on the college level. Of the nine parts that comprise the volume, seven are devoted to man's relationship to the major elements of natural environment, an eighth deals with his relationship to regional complexes, and the last treats with the fundamentals of political geography and international relations. Because of its timeliness, this final section, greatly enlarged and fresh, should find favor with the general reader as well as the student.

Some may feel that too much emphasis is placed on the influence of climate upon human activity throughout the book, the effects of other elements, *viz.*, land and water bodies, topography, soil and vegetation seeming unduly minimized. A well-balanced discussion of the composite influences of natural environment on mass migrations and the diffusion of peoples would not be amiss.

An innovation is the system of referring to the many illustrations. Each reference in the text carries a letter and number, such as "A380," the letter denoting the particular map, chart or photograph on the page designated by the number. In the absence of a conventional table of illustrations, it is unfortunate that the index is incomplete and inaccurate.

Maps and diagrams are well drafted, but the photographs, which are better than average, are not always well placed; *e.g.*, it is difficult to see the connection between a picture of the river-front at Benares, India, and the paragraph on rice production with which it is associated. Among other pedagogic suggestions, the "Note to the Teacher" contains a list of supplementary references.

Principles of Economic Geography. By ELLSWORTH HUNTINGTON. 715 + x pp.; 160 maps, 60 diagrams, 50 tables and 2 plates. New York: John Wiley and Sons; London: Chapman and Hall. 1940. $4.00.

BY the same author, this book closely resembles "Principles of Human Geography" in style and philosophy. Huntington's smoothness and facility of expression lend to both a literary quality not generally found in text-books.

Beginning with an analysis of a sample product, rubber, the author treats systematically the economic geography of plants, animals and minerals. Ensuing parts are devoted to "The Soil and Its Use," "Problems of Relief and Erosion," "The Human Factor," "Food and Diet" and "The Geography of High Productivity." Kinds and distribution of manufacturing, economic functions of cities, paths of commerce and the geographic basis of world trade form the subject-matter of other chapters.

A discussion of the foreign commerce of the United States, especially valuable for its portrayal of the dynamic nature of economic geography, concludes the text. The accompanying bibliography is well selected, and the many good maps, which are thoroughly integrated with the written material, compensate for the absence of photographs.

Dr. Huntington has drawn freely from the earlier "Economic and Social Geography," on which he collaborated with Frank E. Williams and Samuel Van Valkenburg, and these men are considered as assistant authors along with Stephen S. Visher, who criticized the new manuscript.

Economic Geography of South America. By the late R. H. WHITBECK and FRANK E. WILLIAMS. Third edition. 469 + xi pp. Numerous maps, charts, diagrams and photographs. New York and London: McGraw-Hill Book Company. 1940. $3.50.

THIS volume has been revised by the junior author, assisted by William F. Christians, and the material of the earlier editions has been expanded, re-arranged and brought up to date. Although strictly economic geography, it is written from the view-point of world production and consumption, without regard to the internal economic geography of South America.

The treatment is rather encyclopedic, and the many facts would benefit from a frame. Organization is by countries, but each is discussed from its own individual perspective, thus making comparison difficult. Similarly, the trade graphs, a useful feature, are not on the same scale.

Natural conditions are rather lightly touched upon, and many statements leave the reader without the geographic connection. An example is the statement that cabinet wood is hard to get out of the jungle, without mention of the lack of roads due to marsh and teeming vegetation, or of the high specific gravity of many woods, which makes it impossible to float the logs to market.

The concluding chapter, "South America as a Whole," and especially the part comparing that continent with North America, is both useful and interesting. A fairly extensive bibliography follows the text. The illustrations are numerous and generally effective.

College Geography. By EARL C. CASE and DANIEL R. BERGSMARK. Second edition. 767 + ix pp. Numerous maps, charts, graphs, photographs and one plate. New York: John Wiley and Sons; London: Chapman and Hall. 1940. $4.00.

MAJOR improvements in the new edition of "College Geography," which is designed for courses in world

geography, principles of geography or economic geography, consist of a more logical arrangement of chapters, vitalization and expansion of the text and a thorough overhauling of illustrative material. Numerous unnecessary charts and graphs have been deleted or replaced by more useful maps, and the references at the close of each chapter have been brought up to date.

A general discussion of the all-important geographic factor of location and space relationship opens the volume, and is followed by chapters on human relationships to climate, soils and land forms. The larger part of the book is devoted to the regional geography of the several climatic realms, with emphasis on the commercial aspects of agriculture, pastoral activities and the extractive plant and animal industries. Later chapters take up mineral resources and industries, transportation and world trade.

Because of difficulties inherent in the attempt to combine two phases of geography, "College Geography" may give the elementary student a confused and perhaps distorted view of the content of the field. Introduction of the regional organization breaks the thread of the systematic approach to the elements of economic geography. Conversely, the emphasis on economic factors in the regional treatment and the relative lack of discussion of the broader aspects of population distribution, kinds and patterns of human settlements and the geographic foundations of other non-economic cultural phenomena present an incomplete picture of general world geography. Probably this fundamental incompatibility can never be resolved.

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SOCIETIES AND MEETINGS

THE ORGANIZATION OF A NEW SCIENCE GROUP IN THE SOUTH

DELEGATES from practically all the scientific organizations of the South and representatives in scientific and industrial fields of eleven southern states met in Mobile to discuss the need for closer coordination among existing scientific groups and the advisability of forming a new organization.

For years it had been increasingly apparent that despite the existence of very worth-while local, state and regional scientific bodies, very little was actually being done to coordinate and integrate the activities of these organizations and practically nothing, to learn and attack the problems common if not peculiar to the South.

A year ago at the annual meeting of the Alabama Academy of Science, it was agreed that the academy sponsor a gathering of Southern scientists and industrialists in connection with their 1941 meeting to be held at Spring Hill College, Mobile, Alabama. A committee was named and what was but an idea in 1940 is now a reality.

Through the untiring efforts of Dr. George D. Palmer, chairman of the committee on Southern Scientists' Organization, the intensive work of the steering committee meeting on March 19 and those who attended the many business sessions on March 20 and 21, the South now boasts a Southern Association for the Advancement of Science.

For the immediate work of organization, Dr. G. D. Palmer, of the University of Alabama, and Father A. J. Westland, S.J., of Spring Hill College, were named chairman and secretary, respectively, and were authorized to select the committees deemed necessary and prepare the agenda for the successive business sessions. To outline even briefly the reports of all the committees and the spirited discussion that ensued would require more space than was allotted. The recommendations of the nominating committee that were unanimously adopted follow: To Dr. Palmer was accorded the honor of being designated founder and first president of the new group; L. C. Bird, of Richmond, Va., was elected first vice-president, and Fr. Anthony J. Westland, S.J., of Spring Hill College, was named first secretary. These officials were to function only during the Mobile meeting and were named for the distinction of being the society's first officers. As incoming officers, Dr. W. F. Rudd, of the Medical College of Virginia, was elected president, Milton H. Fies, Birmingham, industrialist, vice-president. Dr. G. D. Palmer was named secretary-treasurer to serve three years, and Dr. G. H. Boyd, of the University of Georgia, was chosen president-elect.

It is believed by those responsible for the newly formed organization that the Southern Association for the Advancement of Science is not just another science association but one with a unique and individual character. The proposed objectives may be summarized as follows:

(1) To organize Southern science to cope with Southern problems.

(2) To recognize the fundamental importance of agricultural, industrial and academic research and assemble evidence which would demand a coordinated effort of these three fields in the solving of Southern problems, thus achieving both an efficient conservation and exploitation of all natural resources.

(3) To maintain, various pressing practical problems notwithstanding, the general concept that science trans-

cends regional boundaries, in the belief that the full cultural development of a democracy requires that its science be universal in its scope and free from the burdens of a continual justification of its utility.

(4) To set up a roster of Southern research talent, thus making readily accessible the essential information regarding the available brains and training for (a) specific Southern problems as they arise and (b) Southern contributions to national defense.

A. J. WESTLAND, S.J.,
Secretary
SPRING HILL COLLEGE, MOBILE, ALA.

REPORTS

REPORT OF THE GENERAL DIRECTOR OF THE NEW YORK ZOOLOGICAL SOCIETY

IN this my first report, it would be ungrateful not to thank my three distinguished predecessors, Hornaday, Townsend and Blair, for the physical and scientific heritages which they have bequeathed.

Forty years ago, Dr. Hornaday remarked that the first year of the actual existence of a zoological park or garden was necessarily its year of severest trial. Not only were there sources of anxiety in adapting the animals to their new quarters and to their curators and keepers, but the adjustment of the institution itself to the needs of the public was of paramount importance.

Two years later, Dr. Townsend, reporting on the first two months of the Aquarium, said that most of his time was devoted to studying the needs of the plant which he had just taken over and to preparing plans for its further development.

There still are trials and anxieties. The continuing adjustment of these great institutions to the needs of the public is *still* of paramount importance. Plans *still* must be prepared for further development. To be static to-day is tantamount to decay. However, it is not the purpose of this report to discuss problems, but rather to render to the society an account of six months' stewardship.

First a note of appreciation for the whole-hearted cooperation of the entire staff, from directors and curators down to messenger boys. The proven potentialities of the personnel permits a report of improvements, having a contract value of over $25,000.00, effected entirely by the staffs of the two institutions. This type of super-maintenance makes the Zoo and Aquarium much more attractive to the public which they serve.

The greatest accomplishment has been the completion of the contract for the first two units of the African Habitat Group, provided through the generosity of a member of this society. Dr. Hornaday once said, "The actual task of new and previously untried accommodations for animals is, to those who plan and erect them, inevitably a source of great anxiety." The lions have already trod their new island in the new development and have also tried the moats surrounding it. The benefit of seeing animals at close range without intervening bars is, however, worth all the anxiety in the world, and we are confident that the African Plains will be a source of great educational value and enjoyment to the public when they are opened this spring.

My colleague, Belle Benchley, confesses that when she takes visitors around her Zoo in San Diego she usually shows space where she *plans to build* rather than cages and enclosures *already built*. I hope to enjoy the same healthy outlook. Twenty adjacent acres of the old bison range remain available for the expansion of the African Group, and it is hoped that my second annual report will boast of additional units being built for the elephant, the hippopotamus, the rhinoceros and the giraffe.

Other noteworthy improvements include the complete reroofing of the lion house by the city and the start of construction, by the WPA, of a model farm group, east of the Bronx River, where domestic farm animals will be exhibited.

Reaffirming the tenet set forth in our charter that the institutions operated by this society are for the promotion of zoology and kindred subjects, as well as for the instruction and recreation of people, special efforts have been made to provide our visitors with greater interest and entertainment. On the one hand, for example, improved labels help to identify mixed bird collections, while on the other, recognizing the fact that people will feed animals, healthful food is now on sale and most of the animals may be fed without any fear of resulting illness, to the great enjoyment, incidentally, of the public which feeds them.

Elephants, camels and llamas have joined the ponies in providing children with rides, an easy (and profitable) way of overcoming the fear of animals which children so often experience.

Improvements have been effected in food and trinket merchandizing, and there have been healthy increases in these revenues, as well as in parking receipts. These monies are earmarked, as you know, for the purchase of more animals.

Working hours of the staff have been changed so that the greatest available number of employees are on duty during the peaks of attendance.

Two and a half million people came through Zoo turnstiles in 1940 and there were two million visitors to the Aquarium, representing a slight increase over 1939 in the former and a slight decrease in the latter.

Education and science are not being neglected. In 1940 65,000 children in organized groups visited the Zoo and 45,000 visited the Aquarium. In 1941, for the first time, there will be a regular docent service available in the Zoo. Education can not be forced down the public's throat, and the pill will be sugar-coated. We thank the society and other forward-looking groups at the World's Fair for this lesson.

Research continues undiminished, with Dr. Breder's exploration of La Cueva Chica in Mexico, Dr. Beebe's 41st field expedition in Bermuda and the mass of routine research going on all the time behind the scenes which is never of public knowledge, but of tremendous public value.

To education, science and research it is gratifying to add art. There has been tremendous public interest in the few special exhibits held at the Zoo. Starting in October with amateur photography, in a contest in which nearly 800 enlarged prints were submitted for judgment, and continuing with one-man shows by two able young free-lance artists, the revitalized Museum of Heads and Horns attracted 20,000 interested visitors up to the end of the year.

I close with an expression of gratitude to the officers of the society for having provided me with the opportunity of continuing my public service along such thoroughly worthwhile lines, and hope that a year from now I may report on all manner of new things to bring us all definitely nearer to our objective of making the Zoo and Aquarium the finest in the world.

ALLYN R. JENNINGS
NEW YORK ZOOLOGICAL SOCIETY

SPECIAL ARTICLES

THE EFFECT OF AN EXTRA-CHROMOSOMAL INFLUENCE UPON TRANSPLANTED SPONTANEOUS TUMORS IN MICE

FOR several years we have had two strains of mice in our laboratory which were descended from animals that developed from fertilized ova transferred to the uteri of females of another stock. This work was done by Elizabeth Fekete, who made the transfers and developed the two strains of mice. Fertilized ova taken from JAX–dba mice were implanted into the uteri of pregnant JAX–C57 black females, and *vice versa*.[1] Unfortunately, the mice which themselves developed directly from the transferred ova are not at present available for tumor transplantation studies. However, the first to the tenth generations of inbred descendants from these mice have been employed in this study.

In order to determine what extra-chromosomal influence, if any, was exerted on the ova during their development in the uteri of females from unrelated strains, the descendants of the mice that developed from transferred ova received implants of transplantable tumors from each of the two stocks of mice employed. Two different transplantable tumors were used. One was originally an osteogenic sarcoma (L946A) which appeared spontaneously on the tail of a virgin JAX–C57 black female in 1936.[2] It now grows as a fibrosarcoma called L946AII. The other tumor (S91) is a malignant melanoma that originated spontaneously in 1937, in a JAX–dba female at the base of the tail. Both tumors show a high frequency of pulmonary metastases.

Since the work was preliminary, and the mice descended from transferred ova animals were available only in limited numbers for any one generation, the generations and ages were lumped together. However, the results are suggestive, as shown in Table 1. As is usually observed with pure strains of mice, samples of these stocks gave 100 per cent. of positive takes when inoculated with a tumor that arose spontaneously in a member of the stock inoculated. A sample of 300 JAX–C57 black mice all developed tumors when inoculated with L946AII, and similarly 200 JAX–dba animals were all positive to S91, the dba tumor. On the other hand, only 6 out of 52 black mice grew the dba tumor (S91) and 13 of the 52 dba mice were positive when inoculated with the black strain tumor (L946AII). When a pure strain mouse was descended from an ovum that had developed

TABLE 1

PURE STOCKS AND DESCENDANTS FROM TRANSFERRED OVA MICE INOCULATED WITH TWO TRANSPLANTABLE TUMORS

Tumors	JAX stocks inoculated			
	C57 black stock	dba stock	Descendants from black ova grown in dba	Descendants from dba ova grown in blk
L946AII from C57 black	300 = 300 + : 0 –	52 = 13 + :39 –	36 = 36 + : 0 –	107 = 55 + :52-
S91 from dba	52 = 6 + :46 –	200 = 200 + : 0 –	71 = 26 + :45 –	46 = 46 + : 0-

[1] G. Woolley, Elizabeth Fekete and C. C. Little, *Proc. Soc. Exp. Biol. and Med.*, 45: 796–798, 1940.

[2] A. M. Cloudman, *Proc. Soc. Exp. Biol. and Med.*, 37: 492–496, 1937.

within the uterus of another strain female the strain susceptibility, as shown by descendants of this mouse, was not altered toward a transplantable tumor from the mouse strain that developed the ovum. There was, however, a definite indication of an increased susceptibility for the tumor that came from the same mouse strain as was employed to protect and nourish the transferred ovum in its development.

The negative mice were kept for one year before they were discarded. Unfortunately, no negative mice were reinoculated. The reason was that the ultimate outcome of a single transplant of a tumor from an unrelated strain was difficult to determine in the pure stocks until considerable time had elapsed. Both of the tumors employed develop sizable masses in four to five weeks when implanted into the strain that originated them. However, many of the positive blacks with S91 implants showed no masses for several months following inoculation but had well established melanotic tumors at the end of one year. The descendants of transferred ova mice grew the tumors of unrelated strains at a faster rate than did the regular pure stock dba and C57 black mice.

Since the same female was used to foster each developing transferred ova mouse before and after birth, experiments are now under way to test the effect of foster nursing when taken alone. A considerable number of mice are being fostered, but finished data are available on only small numbers of mice as shown in Table 2. Here the JAX–A stock mice were

TABLE 2

TRANSPLANTATION OF TUMORS INTO FOSTERED MICE

Tumors	A stock	A stock young fostered by dba females	dba young fostered by black females
L946AII ..	0	0	5 = 5 + :0 – inoc. at 30 days
S91	6 = 0 + :6 –	4 = 4 + :0 – inoc. at 30 days 7 = 2 + :5 – inoc. at 60 days	5 = 5 + :0 –

fostered on JAX–dba females and JAX–dba young were fostered on JAX–C57 black females.

The six unfostered A stock mice inoculated with S91 first received implants at 30 days and were reinoculated at about 5 months. They were killed at the end of one year without any signs of tumor growth. The fostered A mice inoculated at 30 days all developed large masses and had extensive lung metastases. Where the mice were kept for 2 months before inoculation only two out of seven developed the transplanted tumors and these were delayed for a long time before developing. Unpublished data by Law show a similar result when he used older fostered mice to receive implants of tumors. This would indicate a lessening of the influence in older fostered mice.

In the above data where mixed ages were used for the descendants of transferred ova mice, a similar age influence may have been in operation. The non-transferred pure stock mice were all about 30 days of age when inoculated.

There appears to be an extra-chromosomal influence exerted by the foster female upon the ova of other stock females implanted into the uterus of such a female. One method of testing this influence by the use of transplantable tumors is described. The testing of the effects of foster nursing alone on transplantable tumors is under investigation.

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THE EFFECT OF FOSTER NURSING ON THE GROWTH OF A TRANSMISSIBLE LEUKEMIA IN MICE[1]

THE most extensive reports concerning the factors involved in susceptibility to transmissible leukemia[2,3] show that inoculated leukemic cells grow in practically 100 per cent. of mice of the susceptible inbred strain and in the first hybrid generation involving this strain. Leukemic cells fail completely to grow in mice of other unrelated or resistant strains. From the work that has been done the conclusion has been reached that susceptibility or non-susceptibility to leukemic tissue is dependent upon the relationship existing between the genetic constitution of both the host and the tumor cell. Only a very few exceptional inoculations, that is, negative inoculation in expected susceptible mice or positive inoculation in expected non-susceptible mice, have been recorded for the various types of transmissible neoplastic growths. These, however, have been adequately explained.[4]

The purpose of the present report is to record the behavior in transplantation of a lymphoid leukemia, line $\overline{\text{LL}}$ 449. This tumor was induced in ♀D2001, of the Jax dilute brown strain (D), subline 212 following painting with a 0.3 per cent. solution of 9:10 dimethyl-1:2 benzanthracene in benzene.[5] The carcinogen was applied to the back of the animal from occiput to mid-sacral region twice a week until tumor appearance. At 143 days following initial painting there appeared extreme bilateral axillary, cervical and inguinal lymphadenopathy. The animal appeared dyspneic and was killed *in extremis* a week

[1] The author is recipient of a Finney-Howell Foundation Medical Research Fellowship.

[2] E. C. MacDowell and M. N. Richter, *Jour. Cancer Research*, 14: 434, 1930.

[3] M. D. Schweitzer and J. Furth, *Am. Jour. Cancer*, 37: 224, 1939.

[4] John J. Bittner, *Jour. Genetics*, 31: 471, 1935.

[5] L. W. Law and Marjorie Lewisohn, *Proc. Soc. Exp. Biol. and Med.*, 43: 143, 1940.

later. At necrospy the liver was greatly enlarged, pale and nodular. The spleen, which measured 4.2 × 1.7 × 0.7 cms, was likewise pale and nodular. The mesenteric-intestinal, renal and lumbar nodes showed extreme lymphadenopathy. There existed connective tissue oedema and severe anasarca. The white blood count obtained from ventricle blood was 123,600, and the differential count showed 100 per cent. medium and large lymphocytes.

Inoculations of approximate one cubic millimeter pieces of tumor tissue were made subcutaneously into the right axilla, by use of a sterile trocar. Unless otherwise stated inoculations were made at one month of age.

In the first transplant generation only 4 of 6 D strain, subline 212, mice were susceptible to the leukemic cells. Subsequently, through the following 6 transplant generations there occurred 100 per cent. takes in 31 mice. On the other hand, only 1 of 41 D strain, subline 111, mice and none of 26 Jax C57 black strain (B) mice grew the leukemic cells. Four other distinct lines of lymphatic leukemia similarly induced in subline 212 of the D strain gave 100 per cent. takes in subline 212, nearly 100 per cent. takes in sublines 3 and 4, but grew in less than 10 per cent. of mice of subline 111.

Of 12 D strain, subline 111, mice foster nursed by a D, subline 212, mother 6 were positive to inoculations in the first generation transfer. These mice, however, were 2 months old when inoculated. All resistant D strain mice fostered by a susceptible D mother were positive to fourth generation inoculations. All B strain mice fostered by a susceptible D strain mother grew leukemic cells of the fourth generation transfer. There was complete resistance of 4 B strain fostered mice when inoculated with second generation leukemic cells. These mice, however, were 3 months old when inoculated. None of the 16 B strain mice fostered by the resistant D mother grew leukemic cells. That the failure of B strain fostered mice to grow leukemic cells of the second generation transplant is due to an age factor rather than a virulence factor is indicated by the results of Cloudman in an accompanying report. Experiments are now in progress to test this.

The clinical course of the disease as determined by invasion of leukemic cells, blood counts and length of life following inoculations was very similar in the B strain fostered mice, the resistant D strain fostered mice and in the control susceptible D strain mice.

TABLE 1

REACTIONS OF DILUTE BROWN D AND C57 BLACK B MICE TO INOCULATIONS OF LYMPHATIC LEUKEMIA LINE $\overline{LL}$ 449

Transplant generation	Donor	Host	Reaction	Length of life (days)
G 1	D Subline 212	6 D Subline 111	6 –	
		6 D Subline 212	4 +, 2 –	K31, K31, K31, D63
		10 B by D Subline 111	10 –	
		12 D Subline 111 by D Subline 212	6 +, 6 –	D31, D31, D36, D36, D38, D60
G 2 a)	D Subline 212	4 D Subline 111	4 –	
		4 B by Subline 212	4 –	
		6 B by Subline 111	6 –	
		14 D Subline 111	1 +, 13 –	D30
G 3	D Subline 212	11 D Subline 212	11 +	6 D19, 5 D24
G 4 a)	D Subline 212	5 D Subline 111 by D Subline 212	5 +	D18, D18, D20, D23, D25
		6 B by Subline 212	6 +	K12, K14, D23, D33, D40
		6 D Subline 111	6 –	
		5 D Subline 212	5 +	K12, K13, D24, D25, D33
b)		4 D Subline 111	4 –	
		4 D Subline 212	4 +	D19, D25, D24, D33
c)		6 D Subline 212 by B	6 +	K19, D19, D23, D23, D24, D25
G 5 a)	D Subline 111 by D Subline 212	7 D Subline 111	7 –	
b)	B by D Subline 212	10 B	10 –	
		5 D Subline 212	5 +	D12, 3 D19, D23
G 6	D Subline 212	3 D Subline 4	3 +	D15, D17, D22
G 7	D Subline 212	5 D Subline 3	5 +	K18, K18, K19, D20, D23

Leukemic cells which grew in resistant fostered hosts failed to grow when reinoculated into resistant non-fostered mice. See Table 1. This is further evidence that leukemia developing after inoculation does not result from a proliferation of the lymphocytes of the host.

Data are not yet complete relating to the reaction of susceptible D strain mice deprived entirely of "susceptible" milk. All mice removed within 12 hours following birth and fostered on a resistant B strain mother grew leukemic cells.

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IMMUNIZATION OF DOGS AGAINST RABIES WITH CULTURE VIRUS

THE literature on rabies contains conflicting evidence as to the immunizing potency of rabies vaccines. Positive results were obtained by Fermi in rats, by Stuart and Krikorian in rabbits, by Remlinger, Kelser and Shortt in rabbits and monkeys. In all cases, however, large amounts of vaccine in multiple doses had to be given, one per cent. or more of the body weight. A critical review of the literature was published by Webster.[1]

A primary problem in antirabic control is the immunization of dogs. For practical reasons single massive doses of various types of vaccines have been used, generally with unsatisfactory results. Recent examinations of the potency of various commercial vaccines, made by Webster,[2] showed that only two chloroform vaccines were efficacious in immunizing mice when doses used were relatively five times as large as those given to dogs.

In our work on formolized culture vaccines in mice[3] we found that a large proportion of mice could be immunized with 5 doses of 0.25 cc given intraperitoneally, if cultures having a mouse brain titre of 10,000 were used for making the vaccine. This dosage, however, is also disproportionately large. However, we noted that mice receiving one dose of culture vaccine (0.5 cc) i.p., were immune to a subsequent infective dose of mouse brain virus given intraperitoneally.

This procedure has been tested in dogs with most promising results. Dogs two to four months old were given 10 cc of a formolized tissue culture of the virus or a formolized suspension of infected mouse brain; 7 to 9 days later the dogs received an injection of 5 or 10 cc active culture, also intraperitoneally. About two weeks after the injection of the live culture the dogs were injected into the neck muscles 1.0 cc of 1:200 dilution of mouse brain infected with street virus; the dogs were observed 35 to 52 days. Thus far three different experiments have been completed. Of 9 control dogs 7 (78 per cent.) died, 5 in 14 to 23 and two after 32 and 37 days, respectively. Of 13 immunized dogs all remained perfectly well, ate well and grew normally during the period of observation; no symptoms of any kind were noted. In one experiment the dogs were under observation 57 and in the other two 76 days after the injection of the active culture; none of the dogs showed any untoward symptoms after the injection of live culture. (See Table I).

TABLE I

Virus dilution	Sera from immunized dogs				Serum of control unimmunized dogs
	1	2	3	4	
1:200	3/3	3/3	3/3	3/3	3/3
1:2000	3/1	3/1	3/1	3/0	3/3
1:20.000	3/1	3/0	3/0	3/0	3/2
1:200.000	...	...	...	...	3/1

Neutralization tests demonstrated that the sera of the treated dogs contained neutralizing antibodies. At the end of the observation period in Experiment I, blood was taken from the immunized dogs as well as from the surviving control dog. The neutralization tests were made with different dilutions of mouse brain virus; equal quantities of whole serum and the virus dilutions were mixed, kept in room temperature (24° C) 2 hours and in the ice-box overnight. The following morning three mice were inoculated with each serum virus mixture. The results given in Table I show that the sera of the immunized animals were able to neutralize 100 mouse cerebral lethal doses of the virus.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

APPARATUS FOR INFLICTING SUBCORTICAL LESIONS IN THE RAT BRAIN

ALTHOUGH the Horsley-Clark instrument was originally designed for mammals of medium size there has recently appeared in this journal an article describing certain modifications adapting this instrument for use on the rat (Clark, 1939). Because there are many investigators who do not possess a Horsley-Clark instrument and therefore can not profit from the suggestions advanced in the earlier report, we wish to describe a substitute instrument which has been in use in our laboratory for several years. Our apparatus, which is a modification of an instrument used by Ghiselli (1937), can be constructed by any competent machinist, and has proved a satisfactory substitute for the Horsley-Clark apparatus.

After the rat has been anesthetized with nembutal the scalp incision is made and the skull is trephined. The animal is placed upon the operating table (A). While the rat's head is held level in the lateral plane the ear plugs (B and B′) are firmly seated in the external meatus; and the set screws (C and C′) are tightened to hold the plugs in place. The triangular mouth bit (D) is slipped under the curving incisors,

[1] L. T. Webster, *Am. Jour. Hyg.*, 30: 113, 1939.
[2] L. T. Webster, *Jour. Exp. Med.*, 70: 87, 1939.
[3] I. J. Kligler and H. Bernkopf, *Brit. Jour. Exp. Path.*, 29: 378, 1938.

and the arms to which the bit is attached are pulled away from the animal's head, stretching it tightly and pulling against the ear plugs. At the same time the height of the bit is adjusted to hold the head level in the longitudinal plane. Tightening the set screws (F and F′) makes this adjustment permanent.

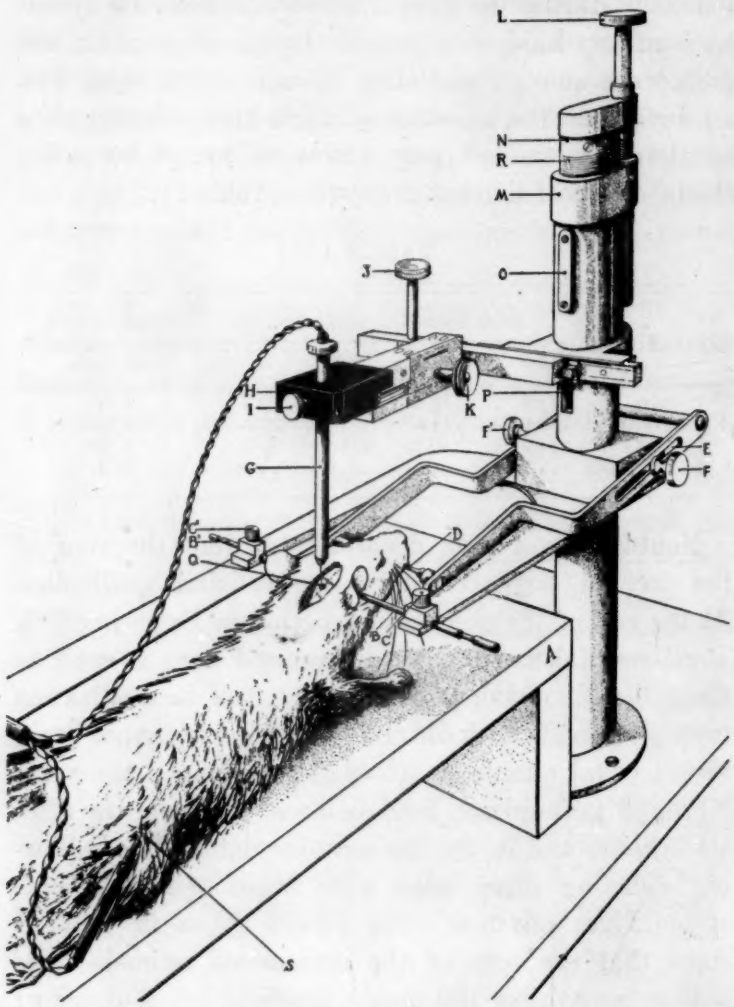

FIG. 1

The electrode holder (G) is adjusted coarsely by sliding it downward through the insulated block (H), and is fixed in position by tightening the set screw (I). The insulated block (H) is attached to a mechanical stage which, in turn, is fastened to a sliding collar (M) that moves vertically on a fixed shaft (N). The mechanical stage, taken from a microscope, is fixed to the collar by two small screws and the insulated block is similarly attached without in any way spoiling the stage for later use on a microscope. The mechanical stage hand screws (K and J) facilitate delicate lateral and longitudinal adjustment of the electrode.

After the horizontal position of the electrode has been adjusted, the entire unit (stage, insulated block and electrode holder) is lowered by turning the large screw (L) which controls movement of the collar (M) on the vertical shaft (N). The depth to which the needle is inserted may be read in millimeters on the scale provided (R). As the collar is moved vertically on the shaft, sidewise movement is prevented by the key (O) on the collar, which fits snugly in the slot (P) in the shaft.

A steel needle inserted in the hind leg of the animal serves as the indifferent electrode. The electrode (Q) in the brain is composed of fine insulated wire. The point of the wire is sharpened and the insulation is removed for a few millimeters above the point. When a direct current is passed through the electrode an electrolytically produced lesion is inflicted about the uninsulated point of the wire.

Cortical destruction is limited to the puncture made when the fine electrode is inserted. The extent of the subcortical lesion is a function of the length of uninsulated electrode, the strength of the current and the duration of its application. We have found it advisable to make the current at a very low voltage (less than 1 volt) and then step it up rapidly to the desired maximum. After the exposure the current is brought down to the low voltage before the circuit is broken. Make and break shocks are thus eliminated. Destruction of relatively large nuclei (*e.g.*, the lateral geniculate) may be achieved with an exposed electrode area of approximately ¾ mm if a current of 8 volts is applied for 30 to 45 seconds. Nearly all the corpus striatum is destroyed if 1.5 mm of the electrode is exposed and a current of 9 volts is applied for 90 seconds.

Absence of cortical landmarks and variability in the size of the rats used makes it difficult to place the electrode accurately. A few preliminary operations serve to determine the correct point of insertion necessary to achieve destruction of a particular region. Attacking the corpus striatum we have found the skull sutures to be the most practicable landmarks. If the electrode is inserted directly through the coronal suture at a point 3 mm laterally from the sagittal suture and lowered to a depth of 4 mm below the surface of the brain the uninsulated electrode lies directly in the center of the corpus striatum.

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